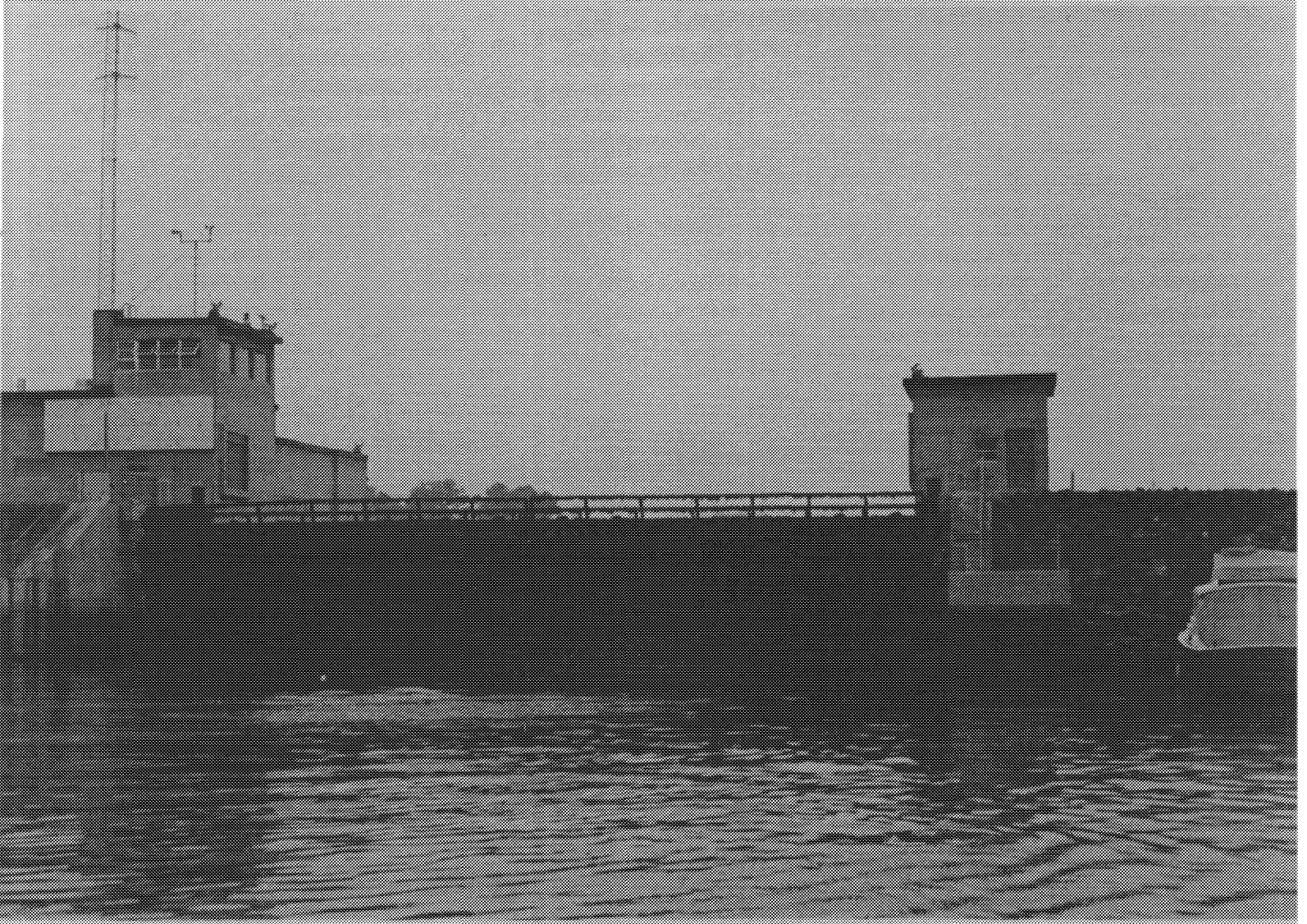
STAMFORD HURRICANE BARRIER

CONNECTICUT

REGULATION MANUAL FOR HURRICANES & COASTAL STORMS



NOVEMBER 1982

REGULATION MANUAL
STAMFORD HURRICANE BARRIER
STAMFORD, CONNECTICUT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

FEBRUARY 1969
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NEDED-W	Stamford Hurricane Barrier Regulation Manual

O Chief, Planning Division **FROM** Chief, Engineering Division **DATE** 7 December 1982 Mr. Mirick/ac/629 **CMT 1**

A copy of the Stamford Hurricane Barrier Regulation Manual dated November 1982 is inclosed for your use. This edition supersedes previous manual dated February 1969. If you have any questions please contact Mr. Mirick, extension 629.

JOE B. FRYAR
Chief, Engineering Division

1 Incl
as

CF
Mr. Mirick
Eng Div Files (112S)

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ACKNOWLEDGMENTS

The following personnel were significantly involved in the preparation and completion of this Regulation Manual:

Robert Mirick, Hydraulic Engineer, Reservoir Control Center - responsible for the preparation of the text, tables and plates.

Joseph Finegan, Chief, Reservoir Control Center - reviewer of the manual for correctness and completeness during preparation.

Margery Cotter, Secretary, Water Control Branch - edited and typed the draft and final report.

P R E F A C E

The Stamford Hurricane Barrier was constructed to prevent or reduce damages associated with tidal flooding in the Stamford Harbor. The main portion of the regulation manual gives a general description of the area, climate, hydrology, tides, hurricanes and coastal storms. Other topics include project features, organization, communications and general procedures.

Detailed regulation procedures and operating criteria for Corps of Engineers use in operating the East Branch navigation gate and pumping station are described in Appendix A. Appendix B contains regulation instructions for the appurtenant features that are operated by the city of Stamford.

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I - INTRODUCTION

1-01. Authorization. This report is prepared pursuant to authority contained in ER 1110-2-240, dated 22 April 1970, Reservoir Regulation and EM 1110-2-3600, dated 25 May 1959, which requires that manuals of reservoir regulation for flood control, navigation and multipurpose reservoirs be prepared whenever one or more of the functions is the responsibility of the Corps of Engineers. Requirements in the "Guide for Preparing Water Control Manuals for Lakes, Reservoirs, Locks & Dams, Reregulating Structures, Controlled Channels & Floodways," US Army Corps of Engineers, Southwestern Division, revised October 1977, were considered during the preparation of this manual.

Following hurricane "Carol" in August 1954, Congress authorized a study (Public Law 71, 84th Congress, 1st session) to determine the feasibility of a protective barrier in the Stamford area. A project was determined to be structurally feasible and economically sound, and subsequently authorized for construction by the Flood Control Act, approved 14 July 1960 (Public Law 86-645, 86th Congress).

1-02. Purpose and Scope. This manual supersedes the Stamford Regulation Manual for Hurricanes and Coastal Storms, dated February 1969. It will serve as a guide and reference source for higher authority, regulation personnel in the New England Division and city of Stamford and others who may become concerned with, or responsible for, regulating the Stamford hurricane barrier. Included in the manual are the following subjects:

a. A brief history of conditions, leading to the authorization of the barrier.

b. A general description of the project area, including topographic features and statistical data relating to population and industry.

c. A brief description of the climate including temperature, average precipitation and snow.

d. A detailed description of storm types by season including specific tidal flood producing storms of the past.

e. A section describing natural astronomical tides, rising sea level datum, storm tides, and tidal frequency.

f. Objectives, responsibilities and operating procedures of the project.

g. Communications with Reservoir Control Center, the barrier, National Weather Service, US Coast Guard and vessels; also navigation warning signals, tide and meteorological data collection.

1-03. Related Manuals and Reports

a. Hurricane Reports

(1) NENYIAC Report. Part II, chapter XXXIX, of the New England-New York Interagency Committee report on "The Resources of the New England-New York Region," prepared pursuant to a Presidential Directive of October 1950, contained a section devoted to hurricanes in the northeastern United States. This report presented a history of hurricanes in New England, an inventory of experienced losses in recent hurricanes, and a discussion of several methods of reducing damages. Specific measures to prevent severe damage at several localities along the New England coast also were discussed briefly.

(2) 1958 Interim Report. An interim report, dated 8 April 1958 and printed in House Document 210, 86th Congress, 1st session, 4 August 1959, presented project analyses. This report recommended the plan authorized by the Flood Control Act approved 14 July 1960 (Public Law 86-645, 86th Congress).

(3) Long Island Sound, Interim Memo No. COE 2, Tidal Hydrology - This report, prepared in June 1973 for the New England River Basins Commission, describes flooding and storms.

b. Navigation Reports. The following reports present information on navigation in Stamford Harbor:

(1) House Document 1130, 63rd Congress, 2d session, 1914.

(2) River and Harbor Committee Document 8, 74th Congress, 1st session, 1934.

(3) River and Harbor Committee Document 29, 75th Congress, 1st session, 1937.

(4) River and Harbor Committee Document 676, 79th Congress, 2d session, 1946.

(5) Westcott Cove has been the subject of two unpublished navigation reports - a preliminary examination submitted in 1936 and a survey report submitted in 1940.

c. Manuals. A Stamford Hurricane Protection Project Regulation Manual and an Operation and Maintenance Manual were completed in

February 1969 and October 1970, respectively.

1-04. Construction. Construction of the project started in April 1965 and became operational in April 1969.

1-05. Operations. There have been 187 operations from October 1968 through September 1982. Table 1 indicates the number of operations each year.

TABLE 1

EAST BRANCH BARRIER
OPERATIONS PER YEAR

Year	Number of Operations	Year	Number of Operations
1968 (Oct-Dec)	6	1975	9
1969	8	1976	7
1970	9	1977	16
1971	14	1978	13
1972	36	1979	17
1973	13	1980	13
1974	16	1981	6
		1982	4

Estimates of "damages prevented" for each operation are available in Reservoir Control Center files.

1-06. General Description of Stamford Area

a. City. The city of Stamford, Connecticut is located in Fairfield County, on the north shore of Long Island Sound, approximately 35 miles east of New York City and 20 miles southwest of Bridgeport, Connecticut (see plate 1). It is adjacent to the towns of Darien on the east and Greenwich on the west. Stamford covers an area of nearly 40 square miles and has a total water frontage, including harbors, of approximately 15 miles. Topography is one of moderate

relief, with elevations ranging from sea level along the coast to a maximum of 560 feet above sea level in the northwesterly portion.

b. Stamford Harbor. The main harbor is an indentation of Long Island Sound, extending inland about 1.5 miles, between Shippan Point on the east and the mainland on the west. Two breakwaters separate the harbor from Long Island Sound. The harbor varies in width from about 1.5 miles at its outer end, to about 0.6 mile at the inner end where it is joined by the East and West Branches. The East Branch is a narrow tidal creek that extends north about 1.5 miles, and the West Branch, about 1.25 miles in length, is the tidal portion of the Rippowam River. Improved channels for navigation have been provided through the main harbor and up both of the Branches. The principal commercial wharves of the city are located along the East and West Branches.

c. Development. Stamford, the major urban center in southwestern Connecticut, was founded in 1641. It was an ideal site for a town, offering a safe harbor, good land nearby for farming and a river to power the local grist mill. It remained a rural village for about 200 years, serving as a trading post for local farmers and a stop for the New York-Boston stagecoaches. The rural nature of the community changed to manufacturing in the 1860's and remained so until the end of World War II. In recent years economic growth has centered on research and engineering activities. Stamford has an area of 39.9 square miles and in 1980 had a population of 102,500.

The hurricane barrier extends across the East Branch. Shipping and boating interests in this waterway were provided by construction of a 90-foot wide navigation gate. Much of the commercial tonnage consists of sand/gravel and metal scrap. Four marinas are located nearby and during the recreation season pleasure craft continually utilize the navigation gate opening.

II - DESCRIPTION OF PROJECT

2-01. General. The project is designed to protect about 600 acres of commercial property including some of the principal manufacturing plants of the city against a standard project hurricane (SPH), a synthetic storm greater than any observed in the past.

The Stamford project is divided into three principal features: (a) the West Branch barrier which protects the area between the West and East Branches, (b) the East Branch barrier which connects to the West Branch and extends across the mouth of the East Branch, and (c) the Westcott Cove barrier which protects the residential area of Rippowam Street and skirts Westcott Cove in Cummings Park. Plate 1 shows the plan of protection for the entire project. The following paragraphs describe the project features and design criteria. Plate 14 provides an aerial view of the area.

2-02. West Branch Barrier

a. General. The West Branch barrier, shown on plate 2, extends along the east bank of the West Branch from the mouth of the Rippowam River to Dyke Park where it connects with the East Branch barrier, a distance of 3,450 feet. The West Branch barrier includes 1,340 feet of anchored concrete piling wall, 100 feet of cantilever concrete wall and 1,950 feet of rock-faced earth dike, with a slope of 1 on 2. Top elevation of this barrier is 17 feet National Geodetic Vertical Datum (NGVD).

Included in the wall portion are an intake and outlet structure for cooling water for the former Hartford Electric Light Company plant. The intake consists of two 4'6" x 6'0" gated openings; the outlet structure consists of a single 8-foot diameter gated opening. These three gates are now permanently closed and city officials indicate the plant will not be used for cooling water purposes in the future. The interior drainage is diverted through a 78-inch diameter drain to the Dyke Lane pumping station.

The Dyke Lane pumping station is a reinforced concrete structure containing two 30-inch and three 48-inch vertical propeller-type pumps. The 30-inch pumps, driven by 150-horsepower electric motors, have a total capacity of 100 cfs. The 48-inch pumps, with a total capacity of 416 cfs, are driven by 500-horsepower motors. The 30-inch pumps are operated automatically, pumping the normal runoff from 197 acres. When runoff exceeds the capacity of the 30-inch pumps, the 48-inch pumps are manually operated.

b. Design Criteria. The walls and dikes of all three barriers are designed to provide protection from a standard project

hurricane. The top elevation of 17.0 feet NGVD for the West Branch barrier was selected to contain a stillwater level of 14.8 feet and also minimize the amount of wave overtopping. The maximum wave runup elevation during the design storm varies from 14.8 to 20.0 feet, causing a peak inflow of 357 cfs with a total overtopping volume of 26 acre-feet. The Dyke Lane pumping station was designed to pass a 10-year frequency peak runoff of 394 cfs coincident with a hurricane tide, plus a maximum cooling water discharge of 194 cfs (no longer needed) from the former electric plant. Although there is no significant ponding storage behind the West Branch barrier and the total of the peak design flows is equal to 588 cfs, the peak flow is now only 394 cfs without the cooling water. Street flooding would commence in the West Branch protected area at elevation 6.3 feet.

2-03. East Branch Barrier

a. General. The East Branch barrier, shown on plate 3, extends easterly from the West Branch barrier in Dyke Park across the East Branch, connecting with higher ground at Wallace Street. It includes 2,840 feet of rock-faced earth dike, a 90-foot navigation gate and the East Branch pumping station, located at the navigation gate structure. Top elevation of the barrier is 17.0 feet and side slopes are generally 1 on 2. The pumping station contains two 30-inch vertical propeller-type pumps with a total capacity of 100 cfs, driven by 100-horsepower motors. The pumps will evacuate interior runoff from the East Branch during periods of gate closure. An 8 x 8 foot sluice gate is provided to drain the harbor in the event the navigation gate sticks in a closed position.

b. Design Criteria

(1) Barrier. The top elevation of 17.0 feet for the East Branch barrier is based on a stillwater elevation of 14.8 feet, with wave runup elevations varying from 14.8 to 22.1 feet. Peak inflow from overtopping is computed at 486 cfs, with a volume of 36.5 acre-feet.

(2) Navigation Gate. The 90-foot navigation opening was considered adequate for present and anticipated shipping. The sill elevation of minus 18.0 feet was selected to allow for future excavation below the present channel bottom elevation of minus 15.5 feet. Effect of the opening on tide cycles behind the barrier in the East Branch is insignificant. Routing calculations have determined that average velocity in the cross section is about 0.6 knot at both flood and ebb of a high spring tide. It is estimated the maximum current in the cross section will be at the center of the opening, near the surface, and will equal approximately 0.8 knot, or about 30 percent greater than the 0.6 knot average. The gate should not be operated if the oceanside is more than 4.0 feet higher than the harborside, or if the harborside is more than 0.5 foot higher than the oceanside.

(3) Pumping Station. The East Branch pumping station was designed for a "Design Hurricane Storm" with the following criteria:

(a) Total pumping capacity of 100 cfs against a design tide level.

(b) Gate closure at 2.0 feet NGVD to allow harbor storage of excess inflow greater than the pumping capacity from a coincident 10-year rainfall.

2-04. Westcott Cove Barrier

a. General. The Westcott Cove barrier, shown on plate 4, extends easterly from Homestead Lane to Auldwood Street, northeasterly to Iroquois Street, northerly to the head of Halloween Cove in Cummings Park and easterly to higher ground in Cummings Park. It includes 4,200 feet of rock-faced earth dike, access ramps and parking areas and the Wampanaw and Cummings pumping stations. Top elevation of the dike from the westerly end to the Wampanaw pumping station is 19.0 feet; the remaining portion is at 18.0 feet. Side slopes of the dike are 1 on 2 on the oceanside and 1 on 3 on the landside.

The Wampanaw pumping station is a reinforced concrete structure housing two 20-inch vertical propeller-type pumps, driven by 60-horsepower electric motors, with a total capacity of 50 cfs. A 4 x 4 foot conduit carries the discharge through the barrier.

The Cummings pumping station is a reinforced concrete structure housing three 30-inch vertical propeller-type pumps, driven by 100-horsepower electric motors and having a total capacity of 140 cfs. The discharge is carried through the barrier by a 5 x 5 foot conduit.

One 18-inch sluice gate and two gate valves, 12 and 6 inches, are located on sanitary sewers that pass through the Westcott Cove barrier. These gates will be closed only in the event of hurricanes.

b. Design Criteria. The barrier is also designed to provide protection from a standard project hurricane. Top elevation of 19.0 feet between the westerly end and Wampanaw pumping station was selected due to lack of a ponding area and the number of houses adjacent to the dike. Based on a stillwater elevation of 14.8 feet, the maximum runup elevation is 18.7. Since most of the area is open land with insignificant ponding storage, a top elevation of 18.0 feet for the remainder of the barrier was selected. The computed overtopping has a peak of 140 cfs, with a volume of 36.5 acre-feet for that portion of the barrier east and north of the Wampanaw pumping station.

The Wampanaw pumping station is designed to discharge peak runoff of 51 cfs from 30 acres associated with a 10-year storm. The peak inflow from interior runoff and the wave overtopping are of such short duration that the 50 cfs capacity of the pumps would prevent significant flood damage from occurring during this design event.

The Cummings pumping station is designed for a 10-year runoff from 112 acres with a peak of 147 cfs. The capacity of 140 cfs also will prevent significant flood damage from a 10-year storm coincident with runoff from wave overtopping. Significant damage would start in the Westcott Cove protected area with flooding at elevation 7.0 feet on Wampanaw Street; however, street flooding occurs about 6.2 feet msl.

III - CLIMATOLOGY

3-01. General. Stamford has a variable temperature climate with frequent weather changes of varying intensity caused by weather systems moving from west to east across the continental United States. There are seasonal differences of temperature and types of precipitation as well as storms.

3-02. Temperature. The mean annual temperature in the Stamford area, based on 75 years of record at Norwalk 8 miles to the east, is approximately 50° Fahrenheit. The average monthly temperature varies from 72° Fahrenheit in July to 28° in January. Freezing temperatures are common from late November through March. Extremes in temperature range from occasional highs just over 100° to infrequent lows in the minus teens.

3-03. Precipitation. The average annual precipitation at Stamford is about 46 inches or about 4 inches per month distributed rather uniformly throughout the year.

a. Rain. The maximum monthly rainfall at Norwalk totaled 17.23 inches in October 1955. The minimum monthly rainfall was 0.07 inch in May 1903.

b. Snow. Snowfall based on 68 years of record at Norwalk averages about 34 inches over the winter season. A maximum of 68.3 inches occurred during the winter of 1916 and a minimum of about 4 inches during the winter of 1923. The snow cover usually reaches a maximum depth in February.

3-04. Storms

a. Large extratropical storms or cyclones occur during the fall, winter and spring months. These storms usually dip southeastward while crossing the continental United States, then regenerate from warm humid air off the Gulf of Mexico or along the Atlantic coast south of New England. Sometimes they develop into severe coastal storms causing high tides and heavy rain (or snow) and are known locally as "northeasters".

b. Tropical storms or hurricanes develop in the summer and autumn months over the tropical waters of the North Atlantic Ocean or the Caribbean Sea and infrequently follow close to the Atlantic coastline, causing severe damage from wind, tidal and river flooding.

c. Local rainstorms usually occur during the summer as convective showers and thunderstorms, with moderate to occasionally heavy rain for short periods of time during or preceding the passage of a cold front. These local storms account for most of the average rainfall during the summer season.

IV - HURRICANES AND SEVERE COASTAL STORMS

4-01. General. There are two types of storms that affect the Stamford area with high tides, wind and heavy rainfall; both are described in the following paragraphs.

4-02. Hurricanes

a. Characteristics. A hurricane is defined as an intense tropical cyclone originating and sustained over a warm tropical ocean (except at the equator) with a counter-clockwise cyclonic wind circulation. It is characterized by winds over 74 miles per hour usually extending outward 50 miles or more from the center, low pressure, torrential rains, very high waves and high coastal tide surges. Another characteristic is a calm center or "eye" which averages about 15 to 20 miles in diameter, where the strongest winds of the storm spiral and rise into the upper atmosphere releasing torrential rains from the moisture saturated air mass. Tropical cyclones from gale to just under hurricane force winds are called tropical storms, possessing many characteristics of a hurricane but of a lesser magnitude.

Hurricane winds generate gigantic waves with the ultimate size depending on the force, wind duration, and the fetch or distance the waves travel. As the hurricane waves approach shoal waters, their forward movement is slowed by bottom friction and forced to rise even higher before breaking and dissipating along the shoreline. Driven by hurricane winds, the breaking waves will run up on a shelving beach or overtop vertical structures well above the normal water level, hence reports of wave and flood damage from 5 to 25 feet above stillwater level are not uncommon.

Flooding also results from the storm tide surge, defined as rise in water above the astronomical predicted tide level for that time of day. The surge is caused by a combination of low barometric pressure, onshore hurricane winds and forward movement of the storm. The rate of water level rise also depends upon the forward movement of an approaching storm from the south and whether the natural tide is rising or falling. Due to the protection of Long Island the full force of surf and wave action at Stamford is not as great as along the south shore and easterly end of Long Island, Rhode Island or the southeast coastline of Massachusetts. Tide surges can build up, however, due to a funneling effect of Long Island Sound when east to northeast winds prevail over the Sound, causing great surges at the westerly end. Hurricane surges at Stamford have reached 5 to 8 feet.

Another characteristic of hurricanes and tropical storms is the accompanying heavy rainfall that continues even as the storm is dissipating over land. Rainfall rates of 1 to 2 inches per hour

have been recorded over Connecticut from tropical storms of hurricane force over the ocean.

b. Historic. Descriptions of summer and autumn storms of hurricane intensity have been reported from the oldest records of the Massachusetts Bay Colony up through recent history. In Connecticut, there are many accounts of intense storms (probably tropical hurricanes) between 1770 and 1900, with the most notable occurring on 19 August 1788, 24 September 1815, September 1821 and 24 August 1893.

c. Present Century. In this century the western end of Long Island Sound has experienced three major hurricanes, with severe coastal flooding in September 1938, August 1954 ("Carol") and moderate flooding from the hurricane of September 1944. Significant flooding has also occurred from other hurricanes and tropical storms in the past 80 years. The tracks of six selected hurricanes are shown on plate 8. Detailed descriptions of three hurricanes are included in the following paragraphs with pertinent tidal information on plate 9.

(1) 21 September 1938. Damage caused by tidal flooding from this hurricane was the greatest ever experienced in the Long Island Sound area, probably the most intense storm in over 300 years. The peak of the hurricane tide arrived in Stamford Harbor about 1-3/4 hours before the predicted high tide. The peak stillwater level reached a height of 11.0 feet NGVD, which was 8.0 feet above the coincident predicted tide height.

The maximum sustained 5-minute wind velocity recorded at Block Island, Rhode Island, about 100 miles east of Stamford, was 82 mph from the southeast with a gust to 91 mph before the anemometer blew away. At New York City, about 30 miles to the southwest of Stamford, the maximum gust and 5-minute velocity in this hurricane were 80 and 70 mph, respectively. At New Haven, Connecticut, 35 miles east of Stamford, and at Hartford, Connecticut, 65 miles northeast, sustained winds of 38 and 46 mph were recorded with gusts of 46 and 59 miles per hour. During this storm the lowest barometric pressure ever offically recorded in New England was 28.04 inches at Hartford and 28.11 at New Haven. The forward speed of this hurricane was about 50 mph from Cape Hatteras to Long Island Sound. The maximum 24-hour rainfall at Bridgeport and New Haven were 5.1 and 6.4 inches, respectively.

(2) 14 September 1944. The peak of the hurricane tide arrived in Stamford Harbor about 2 hours after the predicted high tide. The peak stillwater level reached a height of 9.2 feet NGVD, which was 7.2 feet above the coincident predicted tide height.

During this hurricane the maximum gust in New England was estimated over 100 miles per hour at Hartford. A wind of 99 mph for 1 minute and a 5-minute velocity of 81 mph were recorded at New York

City. At Block Island the maximum sustained 5-minute wind velocity was 82 mph and at New Haven the recorded maximum gust was 65 mph and the sustained 5-minute wind was 33 miles per hour. The minimum recorded barometric pressure in New England during this storm was 28.30 inches at Westerly, Rhode Island, 90 miles east of Stamford. The forward speed of the hurricane was about 35 miles per hour as it approached New England. The maximum 24-hour rainfall at Norwalk and Bridgeport were 4.7 and 5.8 inches, respectively.

(3) "Carol" - 31 August 1954. The peak of the hurricane tide occurred in Stamford Harbor almost simultaneously with the crest of the predicted tide. The peak stillwater level reached a height of 10.3 feet NGVD which was 5.9 feet above the coincident predicted tide height.

During this hurricane a peak gust of 135 miles per hour was recorded at Block Island, Rhode Island, 100 miles to the east. Gusts of 65 mph were experienced at New Haven and Hartford. A maximum velocity of 52 miles per hour was recorded at Stamford. During this storm the minimum barometric pressures recorded were 28.20 inches at Storrs, Connecticut, 85 miles northeast of Stamford, and 28.77 inches at New Haven. The forward speed of the hurricane was approximately 50 mph; maximum rainfall was about 2.6 inches. Plate 13 indicates the extents of tidal flooding.

d. Standard Project Hurricane. The standard project hurricane (SPH) was developed for the design of hurricane protective structures for southern New England, based on the history and analysis of hurricanes in the Narragansett Bay and Long Island Sound areas. The SPH is representative of the most severe combination of meteorological conditions that are considered reasonably characteristic of the region. The design hurricane was established through the cooperation of the National Weather Service and the Beach Erosion Board, assisted by the Research Foundation of the Agricultural and Mechanical College of Texas. It is based on the transposed Cape Hatteras hurricane of September 1944, which is the severest storm, according to SPH indices by the National Weather Service. The SPH criteria were established by enveloping observed hurricane parameters such as central pressure and radius of maximum winds separately and smoothing geographically. In deriving the SPH, the 1944 hurricane was transposed so that it would be entirely over water between Cape Hatteras and the New England coast, resulting in a central pressure index 27.85 inches near the mouth of Narragansett Bay, Buzzards Bay and Long Island Sound. This index was approximately 0.5 inch lower barometric pressure than actually occurred in September 1944. The center of the transposed hurricane was moved northerly with forward speeds of 30 and 40 knots along a track passing about 50 nautical miles west of Montauk Point, Long Island, New York.

4-03. Coastal Storms

a. Characteristics. Nontropical coastal events that affect

New England are storms that develop or regenerate over the water off the Atlantic coast from Florida to New Jersey. Although wind and tide surges from these storms are not as great as hurricanes, they pose a more frequent threat to the Stamford area due to the accompayning gale winds. Sometimes coastal storms stall off the southeast coast of New England and produce high tides that persist for several days. An example of this is the October 1955 event when high tides continued from 14-16 October.

b. Historic. Nontropical storms with gale winds, heavy rain and high tides occur predominantly in Connecticut during the late fall, winter and spring months. Prior to 1900, accurate records of storm tide levels along the Connecticut coastline are scarce.

c. Present Century. Since 1938, tide records have been maintained at various locations. Following are detailed descriptions of severe coastal storms that have affected Stamford:

(1) February 1978. A storm characterized as "the blizzard of 1978" developed off the Carolina coast on 6 February and moved slowly northward along the Atlantic seaboard where it stalled for nearly 12 hours between Long Island and Cape Cod before redeveloping further eastward on the 7th. Accompanying winds gusted to over 50 miles per hour in New York and Connecticut, with gusts to 79 and 92 mph at Boston and Chatham, Massachusetts, respectively. The tide at Stamford reached 9.8 feet NGVD which was the fourth highest of record, 5 feet above the predicted tide level. Maximum wind gusts at the barrier were 45 miles per hour from the north-northeast and the minimum barometer reading was 29.28 inches (see plate 10 for barrier operation). No significant runoff occurred as a result of this snowstorm.

(2) November 1950. The storm of 25-26 November 1950 started as a disturbance over Virginia before intensifying rapidly and moving north-northeastward and reaching New England on the 25th. This resulted in the most violent hurricane storm in decades, with tidal flooding experienced along the entire Connecticut coast and particularly severe west of New Haven. The two crests of severe tidal flooding, approximately equal in height, occurred on two successive tide cycles. The maximum level at Stamford was 9.5 feet NGVD. At New Haven, the recorded maximum 1-minute sustained wind velocity and gust were 55 and 77 miles per hour, respectively, while corresponding velocities at Hartford were 70 and 100 mph. The wind shifted slowly from east to southeast, then south, thus becoming directly onshore at all locations along the Connecticut coast during the storm. The strong gale wind velocities were of longer duration than in the 1938 and 1944 hurricanes. Total rainfall was 1.04 inches at Stamford and 1.76 at Norwalk.

(3) November 1968. This storm developed near the Virginia Capes on 12 November, with the path passing through western Rhode Island, eastern Massachusetts and eastern New Hampshire and Maine on

13 November. Strongest winds and heaviest precipitation were east of this path along coastal Massachusetts, but the heaviest snowfall occurred to the west and north. Gusts to 100 miles per hour were unofficially reported at Block Island with barometer readings near 29.00 inches. Storm surge tides and high wave action were major destructive elements. Tides were 2 to 4 feet above normal along the Massachusetts coast. Heights of 3 to 6 feet above normal occurred along the Rhode Island and Connecticut coasts, reaching 6.6 feet above predicted tide for a peak of 9.4 feet NGVD at Stamford. Total precipitation of 1.2 inches of rain occurred on 12 November.

(4) November 1953. The storm of 6-7 November 1953 commenced during the early morning of the 6th when a low pressure area off the Georgia coast moved rapidly up the Atlantic seaboard, developing into a major storm and bringing rain, snow and high winds to northeastern United States. It reached southern New England the night of the 6th, moving northerly over the rest of the section the following day. Rainfall amounts were 1 to 1.5 inches over coastal Connecticut. The severest tidal flooding crest occurred on the 7th, coincident with the first predicted high tide for the day at most locations on Long Island Sound. The maximum tide at Stamford was 9.2 feet NGVD. Maximum wind gusts at Block Island, Rhode Island were 98 miles per hour. Although the entire New England coast was affected to some degree by this storm, damage was heaviest along the Connecticut shore of Long Island Sound.

(5) October 1955. The storm of 14-16 October resulted from an intense low pressure system moving northward from Florida and stalling off the New Jersey coast for three days. In addition to the gale winds, unusually heavy rains (6 to 12 inches) hit the area. The maximum rainfall at Stamford for this coastal storm occurred during 14-20 October 1955, with 4.86 inches of rain falling on 15 October and 7.08 inches on the 16th. The outstanding feature concerned tide levels at the western and central portions of Long Island Sound. Five consecutive damaging high tides occurred, with surges ranging from 2 to 5 feet. Tide levels for this storm reached 7.4 and 7.5 feet NGVD on the 14th, 7.9 and 7.4 feet on the 15th, and 7.7 on the 16th.

V - TIDES AND TIDAL FLOODING

5-01. Astronomical Tides. Tides in Stamford Harbor are semidiurnal, with two high and low waters occurring each lunar day. The mean range of tide is 7.2 feet as measured between a mean low water of 3.0 feet below National Geodetic Vertical Datum of 1929 (NGVD) and a mean high water at 4.2 feet above NGVD. Spring tides have a mean range of 8.3 feet and a maximum probable range of approximately 12.0 feet. A maximum probable spring tide will reach elevation 6.7 feet above NGVD (2.5 feet above mean high water). The time interval for a complete tidal cycle averages about 12 hours and 25 minutes. Tidal data for Stamford are summarized in table 2.

TABLE 2

ASTRONOMICAL TIDES
STAMFORD, CONNECTICUT

	Feet
Mean Tide Range	7.2
Mean High Water (above NGVD)	4.2
Mean Low Water (below NGVD)	3.0
Mean Spring Tide Range	8.3
Mean Spring High Water (above NGVD)	4.8
Maximum Probable Spring High Water (above NGVD)	6.7
Minimum Probable Spring Low Water (below NGVD)	5.3

5-02. Rising Sea Level Datum. During the latter part of 1968 this office was notified by the US Coast and Geodetic Survey of a revision in the tidal benchmark data for Connecticut, indicating that the mean low water level along Stamford Harbor had risen about 0.4 to 0.5 foot with respect to NGVD. This revision reflects the general rise in sea level that has been observed for many years and which for Stamford Harbor is estimated to have occurred at the rate of 0.01 ft/yr. It is understood these revised values for mean low water elevations are based on the 19-year series of tide observations from 1941 to 1959. Previous values were based on observations for 1924 to

1942. A rise of 0.4 foot in sea level at Stamford Harbor has occurred between these two series of observations. The National Ocean Survey is currently compiling another revision to this tidal benchmark data for the period 1960 to 1978; however, these data are not yet available.

An effect of the rising sea level phenomenon is to slightly raise both the maximum tide level during a hypothetical recurrence of a past storm and the computed level of the design hurricane tide at Stamford Harbor. The effect upon the historic storm tide data is accounted for in the statistical analysis of tide stage-frequency by pro rata adjusting upward all values in the record to the level of the sea for the year in which the frequency analysis is made. In the case of the design tide there are numerous assumptions and uncertainties involved in deriving a design storm tide elevation such as characteristics of the design hurricane and its track, computation of the surge, coincidence with and height of normal tide, and height and runup of waves. After weighing all these factors, it is considered that the design grades for the existing barrier remain adequate and the project will continue to provide Stamford with a high degree of protection from future hurricanes.

5-03. Storm Tides. A recording tide gage located at Stamford Harbor has been maintained by the Hartford Electric Company from 1950 through 1960. Additionally, a Corps of Engineers recording tide gage has been in continuous operation since September 1968 at the Stamford hurricane barrier. This data has been supplemented by high watermark elevation data collected at Stamford with records of the National Ocean Survey tide gages. At Bridgeport, stages related to Stamford Harbor have also been used to develop a list of selected peak storm tides at Stamford. Table 3 shows the observed stillwater elevations of these tidal floods.

5-04. Tidal Flood Frequency. A tide stage-frequency relationship for Stamford has been developed utilizing a composite of a Pearson type III distribution function (with expected probability adjustment) for analysis of adjusted annual maximum stillwater tide levels and a graphical solution of Weibull plot positions for partial duration series data. Historic tidal flood data for Providence, Rhode Island, together with a stage correlation between Stamford and Providence were utilized to adjust the Pearson type III statistics and effectively extend the historic period at Stamford. The resulting tide stage-frequency relationship for Stamford is shown on plate 7.

5-05. Tidal Flood Profiles. Tidal flood profiles in the Stamford area for experienced hurricanes and severe coastal storms are included in the Corps of Engineers report prepared for the New England River Basin Commission, entitled: "Long Island Sound, Interim Memo No. COE 2, Tidal Hydrology," dated June 1973.

TABLE 3

STAMFORD HARBOR
MAXIMUM TIDE ELEVATIONS

Date		Stillwater Elevation (ft NGVD)	
21 Sep 1938	Hurricane	11.0	(1)
24 Aug 1893	Hurricane	10.3	(2)
31 Aug 1954	Hurricane "Carol"	10.3	(1)
6 Feb 1978		9.8	
25 Nov 1950		9.5	
12 Nov 1968		9.4	
14 Sep 1944	Hurricane	9.2	(2)(3)
7 Nov 1953		9.2	
19 Feb 1972		9.0	
25 Oct 1980		9.0	
19 Feb 1960		8.5	
13 Apr 1961		8.4	(3)
6 Mar 1962		8.4	(3)
28 Jan 1966		8.4	(3)
12 Sep 1960	Hurricane "Donna"	8.3	
4 Apr 1973		8.2	
25 Dec 1978		8.2	
9 Jan 1978		8.0	
15 Oct 1955		7.9	
26 Dec 1969		7.9	
30 Nov 1944		7.8	(4)
20 Mar 1958		7.8	
9 Dec 1973		7.8	
2 Dec 1974		7.8	
31 Oct 1947		7.7	(4)
16 Feb 1958		7.7	(3)
21 Sep 1961	Hurricane "Esther"	7.7	(3)
10 Nov 1962		7.7	(3)
8 Nov 1977		7.7	
9 Aug 1976		7.6	
12 Mar 1959		7.5	
22 Dec 1972		7.5	
24 Jan 1979		7.5	

(1) Based on high watermarks at Stamford
(2) Estimated from historical account at Stamford
(3) Based on record of tidal recording gage at Yellow Mill bridge, Bridgeport and stage related to Stamford
(4) Based on record of staff gage located at Pleasure Beach bridge, Bridgeport and stage related to Stamford

VI - PROJECT REGULATION

6-01. General. Based on weather and tide conditions at the project and advisories from the National Weather Service, regulation of the project by the Corps and the city of Stamford is accomplished in accordance with procedures described in this manual. The following paragraphs discuss responsibilities of each agency, operational considerations and reports.

6-02. Responsibilities

a. Corps of Engineers

(1) General. The Corps is responsible for operation of the East Branch barrier navigation gate, pumping station and appurtenant structures. In the performance of its duties the Corps maintains close liaison with the National Weather Service, US Coast Guard and city personnel. Appendix A includes the specific duties of the Reservoir Control Center and the project manager.

(2) Reservoir Control Center. The Reservoir Control Center will direct the operation of the navigation gate and the pumping station during abnormal tide conditions. RCC is responsible for reservoir regulation activities at NED, which include:

Preparation of regulation manuals

Continuing studies of regulation procedures

Annual reports on regulation activities

Data collection and reporting networks

Analyses of actual operations

Training of personnel

Publishing an updated telephone directory for use during flood emergencies

(3) Project Manager. For administration and maintenance purposes the project manager (i.e., Maintenance and Operations Operator) is under the jurisdiction of Operations Division. However, when operation of the barrier may be necessary to prevent tidal flooding in the protected area, the manager receives his instructions directly from RCC personnel. He is responsible for closing or opening the navigation gate and operating the pumps at the East Branch barrier. He is also responsible for activating all navigation safety devices - lights, strobeacons, horns, as well as issuing bulletins to the Coast Guard, in accordance with procedures described in Appendix A.

(4) Naugatuck River Basin Manager. The basin manager is responsible for providing adequate manpower coverage for the Stamford barrier whenever staffing the project for abnormal high tide conditions is requested by RCC during off-duty hours (regular duty consists of an 8-hour day, Monday through Friday). For safety reasons two persons should be assigned during these staffings.

b. National Weather Service. The National Weather Service has no direct role in regulation activities of the barrier. However, this agency identifies and locates hurricanes and coastal storms posing a threat to southern New England and provides continual updating on weather forecasts, weather conditions and tidal surges. RCC receives this data over the NWS Teletype Network and personally via phone. The NWS Boston office forecasts tidal surges and precipitation for Connecticut coastal areas. In addition, through the auspices of the NWS, the National Ocean Survey of NOAA provides monthly computer printouts of hourly and daily high and low tide level predictions for Stamford Harbor. Examples of these predictions are shown on plates A-13 and A-14.

c. US Coast Guard. If closure of the navigation gate is or may be necessary, the project manager will issue special bulletins to the Coast Guard in New Haven, Connecticut for broadcast to mariners (refer to plate A-6). Following receipt of bulletins concerning gate operations, the Coast Guard will broadcast them over the marine radio network. Bulletins for hurricanes probably will be issued at least 6 hours in advance of closing; however, during most coastal storms less than 1 or 2 hours advance notice will be given.

d. City of Stamford. The city will be responsible for the operation of the Dyke Lane, Wampanaw and Cummings pumping stations, in accordance with instructions in Appendix B of this manual and the Operations and Maintenance Manual, dated October 1970. The city will arrange to receive NWS forecasts because the initial mobilization and preparedness are based on weather forecasts and conditions at the barrier.

6-03. Regulation and Operational Considerations

a. General. Various elements that must be considered and evaluated in prescribing and directing operational procedures for hurricanes, coastal storms, and unusual conditions at the project are:

- Timing considerations for manning the barrier during off-duty hours.

- Discharge capacity of the East Branch pumping station.

- Low street levels with inadequate storm drainage facilities at several locations which result in street flooding and hazardous winter driving conditions.

- East Branch navigation gate procedures.

- Personnel required to operate barrier.

b. Timing Considerations. Timing considerations for manning the barrier during off-duty hours depend on:

(1) Advance warning time necessary for regulating personnel to be alert to weather and tide conditions and to contact the NWS for tidal surge forecasts at Stamford.

(2) Notifying the project manager or the basin manager by phone. Since personnel are not required to be at their residences during off-duty hours, it is necessary to have several personnel trained to operate the barrier.

(3) Travel time from residence to barrier may take 1 to 2 hours depending on weather and travel conditions.

(4) Usually 3 to 4 hours in advance of the predicted peak tide are necessary to be at the barrier and, occasionally, the observed peak tide may occur about an hour before the predicted tide.

c. Pumping Interior Runoff. The East Branch has an interior drainage area of 1,200 acres, while the harbor has a surface area varying from 60 to 80 acres. Therefore, with a pumping capacity of 100 cfs the harbor can be lowered about 0.1 foot per hour when the navigation gates are closed; however, 1 inch of runoff would create a rise of about 1.5 feet (see plate A-10).

Whenever it is expected the East Branch pumping station will be unable to keep up with interior runoff into the harbor, gate closure should commence at a lower ocean elevation than with negligible rainfall. This allows for harbor storage of excess inflow greater than the pumping capacity. Therefore, the navigation gate should be closed at elevation 2.0 feet NGVD for hurricanes as directed in the operating procedures of Appendix A. An operating guide for coastal storms contains criteria based on expected tide levels, rainfall, or below freezing temperatures (see plate A-5).

d. Low Street Levels. Under certain conditions, Halloween Boulevard, John Street and the corner of State and Canal Streets can cause an operation of the navigation gate at a lower level than ordinarily considered the beginning of damage (see plates 11 and 12).

(1) Moderate to heavy rainfall will flood streets at high tide due to low catch basin elevations and inadequate drainage facilities.

(2) Freezing temperatures (below 28^{0} Fahrenheit) can cause hazardous ice problems instead of minor flooding.

(3) Heavy snowfall causes additional difficulties as plowing becomes very difficult, when saltwater backs up through the catch basins and freezes with the snow on the streets.

e. Navigation Gate Procedures

(1) Time of gate opening or closing is approximately 20 minutes.

(2) The gate should not be opened if the harbor level is more than 0.5 foot higher than the ocean level. If it becomes necessary to open the navigation gate under these conditions then the 8'x8' bypass gate should first be opened to help equalize the levels (refer to plate A-9 for bypass conduit rating curve).

(3) Discretion should be used in initiating closure if approaching vessels are a short distance from the barrier and will be passing through within a few minutes. The size of ship in the narrow entrance channel, ocean level and rate of rise also must be considered in delaying closure for marine traffic.

f. Personnel. For safety reasons, two people should be assigned when the barrier is staffed during off duty hours. Both should be fully aware of all procedures necessary for operation of the barrier.

6-04. Operating Procedures. Standard and Emergency Operating Procedures have been developed for the navigation gates, the East Branch pumping station and elements of the project. Appendix A and plate A-4 contain operating procedures for the navigation gate and East Branch pumping station. Appendix B and plates B-3 and B-4 contain operating procedures for other elements of the project.

6-05. Reports

a. Weekly Reports. The barrier operator makes a routine report via radio or telephone to RCC each Friday morning. This report assures continuous contact between the operating personnel and RCC and also serves as an equipment and communications test. The report, shown on plate A-12, includes the preceding 24-hour precipitation and current weather, ocean and harbor tide levels, telemark reading, surge and other miscellaneous data.

b. Other Reports. Supplemental radio and telephone reports are made by the operator to RCC whenever unusual circumstances occur or if a special report is requested by RCC. Time and frequency of these reports are dependent upon weather conditions or specific instructions from RCC. All reports, instructions, records of unusual circumstances at the barrier and information pertinent to operation of the navigation gate and East Branch pumping station are entered in logs (see Appendix A). A log is maintained by both the barrier operator and RCC.

c. Pumping Station Operation Logs. All pump and gate operations are noted on logs (shown in Appendices A and B); these forms indicate date, time of day, water levels, gate and pump operations, and remarks.

d. Regulation Bulletin. RCC will issue a regulation bulletin pertaining to storm data, tide levels and benefits for each significant storm event.

VII - COMMUNICATION AND DATA COLLECTION

7-01. Communication Networks. There are various communication networks in operation between project managers, RCC and others: (a) telephone, (b) radio transmission via microwave, (c) radio with incoming ships, and (d) telephone with US Coast Guard and National Weather Service.

7-02. Communications with Project. Communications between the project manager, basin manager and RCC are made via the NED radio network and/or telephone. The project manager also has radio facilities to monitor US Coast Guard bulletins and contact ships approaching the barrier. A tape recorder attached to a separate telephone at the barrier provides information to the public concerning gate operations. An automatic telephone transmitter 'telemark' in the barrier office can be called to determine ocean tide levels at any time. Audio tones (beeps) transmit as follows:

Clicks heard at beginning indicate the equipment is operating.

___ long tone indicates zero

_ _ short tones indicate digit which is then followed by a short pause

The equipment operates to transmit two readings per call. Examples of telemark readings for ocean levels of 3.32 feet, 0.21 foot and -3.98 feet NGVD are shown below. In determining ocean levels below 0 foot, the reading should be subtracted from 100.00.

(03.32) ___ _ _ _ _ _ _ _ _ _ long pause ___ _ _ _ _ _ _ _ _ _ _

(00.21) ___ ___ _ _ _ long pause ___ ___ _ _ _

(96.02) _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ___ _ _ long pause

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ___ _ _

If no signal is obtained the US Geological Survey should be notified as soon as possible.

7-03. National Weather Service. The National Weather Service at Boston is responsible for weather and tide forecasts along Long Island Sound and can be contacted via telephone on a 24-hour basis. Supplemental forecasts are also received by the project manager from New York NWS.

7-04. US Coast Guard. Communication with the US Coast Guard is required in order for them to issue and broadcast advisory messages as

to the current and projected status of the barrier gates for navigational interests.

7-05. Navigation Warnings and Controls. In addition to the required navigation aids, the following safety features are provided:

a. Obstruction Lighting

(1) Two sets of neon signs, one on the oceanside and the other on the harborside of the east abutment, indicate the status of the navigation gate. When the gate is open, the signs read "OPEN" in green lighted letters. When the gate starts to close, the lights automatically change to "CLOSED" in red letters.

(2) Four 500-watt floodlights in the gate area provide general illumination. Three additional lights on each abutment are directed into the gate channel areas and are turned on from sunset to sunrise by an astronomical clock-controlled circuit.

b. Navigation Control Signals

(1) Two red strobeacons (condenser discharge lights), located on Jacks Island and Lindstrom Point, are provided. The lights are on a 20-second interval flashing rate and radio controlled to change to a 2-second interval when the gate starts closing and continuing until the gate is fully open again (see plate A-8).

(2) A 100 db horn mounted on the operating structure will sound an alarm when the gate is in motion.

c. US Coast Guard. The RCC will request the barrier operator to issue special bulletins to the USCG for broadcast to mariners whenever it is expected that the navigation gate will be operated during hurricanes and coastal storms (see Appendix A).

7-06. Data Collection at Barrier

a. Ocean and harbor water levels are displayed and recorded on charts for permanent record (plate 6).

b. Meteorological data such as wind speed, wind direction, barometer, and precipitation are displayed and recorded on punch tape or charts. This information is transmitted to RCC via radio when requested.

7-07. Maintenance of Gages and Operating Aids

a. Tide level indicators are maintained by the US Geological Survey as part of the Cooperative Stream Gaging Program.

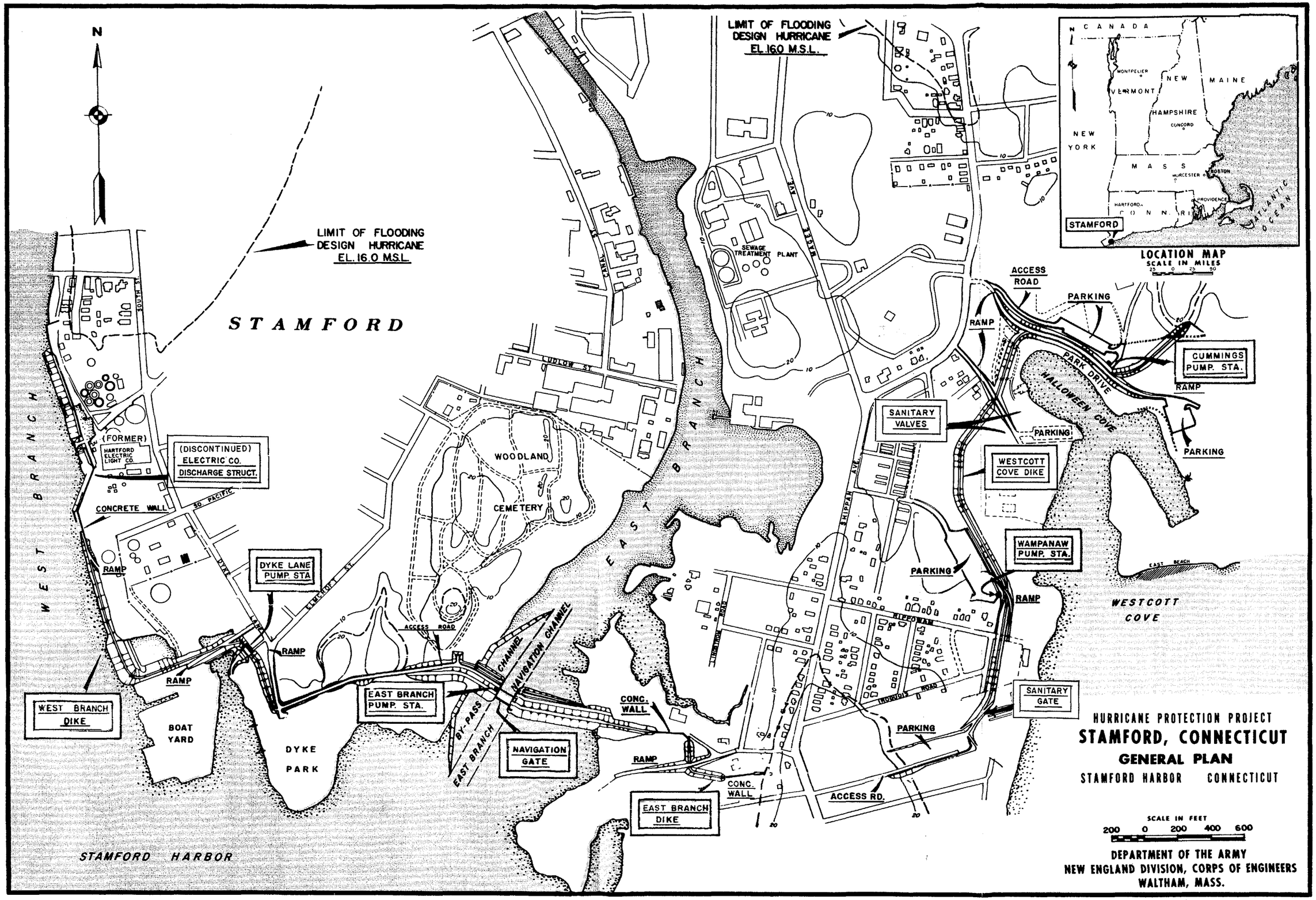
b. Meteorological equipment is serviced by the National Weather Service.

c. The radio is serviced by NED.

d. The remaining operating aids - lighting, warning beacons, etc. - are the responsibility of the barrier operator.

CORPS OF ENGINEERS

U. S. ARMY



HURRICANE PROTECTION PROJECT

STAMFORD, CONNECTICUT

GENERAL PLAN

STAMFORD HARBOR CONNECTICUT

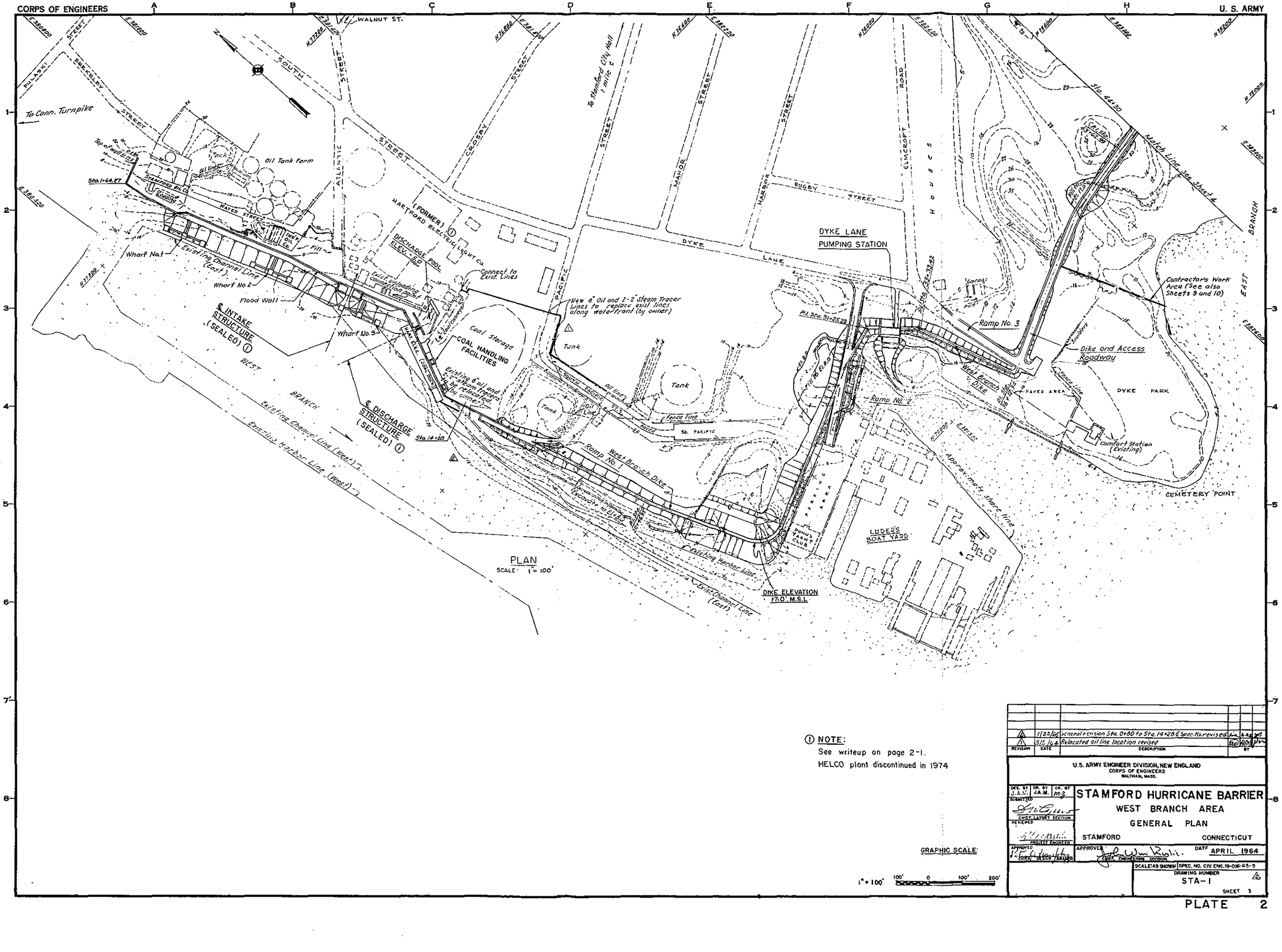
SCALE IN FEET

200 0 200 400 600

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE NO. 1

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE: 1" = 100'

① NOTE:
See writeup on page 2-1.
HELCO plant discontinued in 1974

GRAPHIC SCALE:
1" = 100' 100' 0 100' 200'

REVISION	DATE	DESCRIPTION	BY
2	1/22/66	General revision Sta. 0+80 to Sta. 14+28 & Spec. No. revised	
1	5/2/64	Relocated oil line location revised	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.A.M. | DR. BY J.A.M. | CK. BY M.J.
SUBMITTED: CHIEF, LAYOUT SECTION
REVIEWED: PROJECT ENGINEER
APPROVED: CHIEF, DESIGN BRANCH

STAMFORD HURRICANE BARRIER
WEST BRANCH AREA
GENERAL PLAN

STAMFORD CONNECTICUT

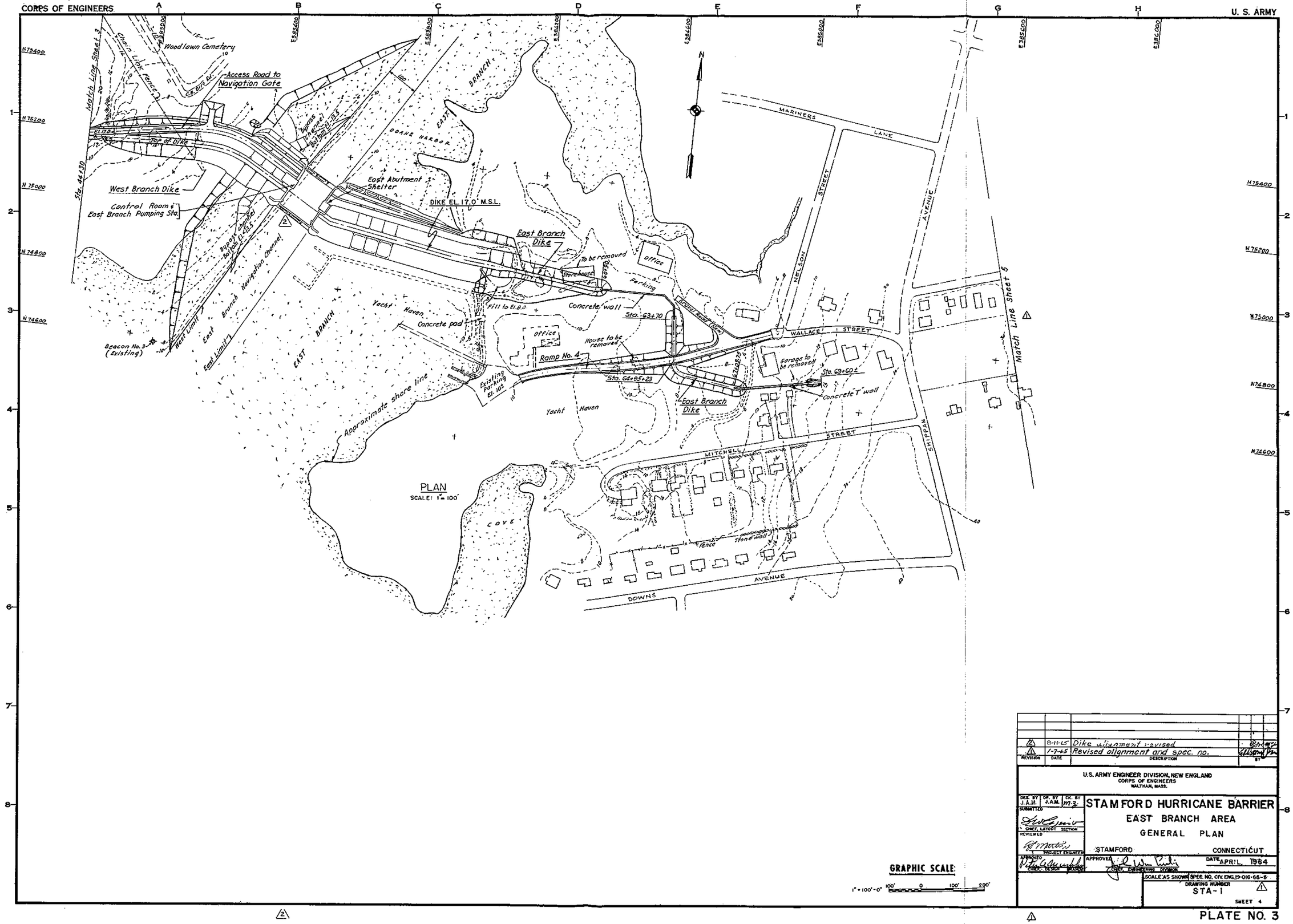
APPROVED: Chief, Engineering Division
DATE APRIL 1964

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-010-65-5
DRAWING NUMBER STA-1 (2)
SHEET 3

PLATE 2

CORPS OF ENGINEERS

U. S. ARMY



REVISION	DATE	DESCRIPTION	BY
2	8-11-65	Dike alignment revised	
1	1-7-65	Revised alignment and spec. no.	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.A.M. | DR. BY J.A.M. | CK. BY M.T.Z.

SUBMITTED: CHIEF, LAYOUT SECTION

REVIEWED: PROJECT ENGINEER

APPROVED: CHIEF, DESIGN BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

DATE APRIL 1964

STAMFORD HURRICANE BARRIER
EAST BRANCH AREA
GENERAL PLAN

STAMFORD CONNECTICUT

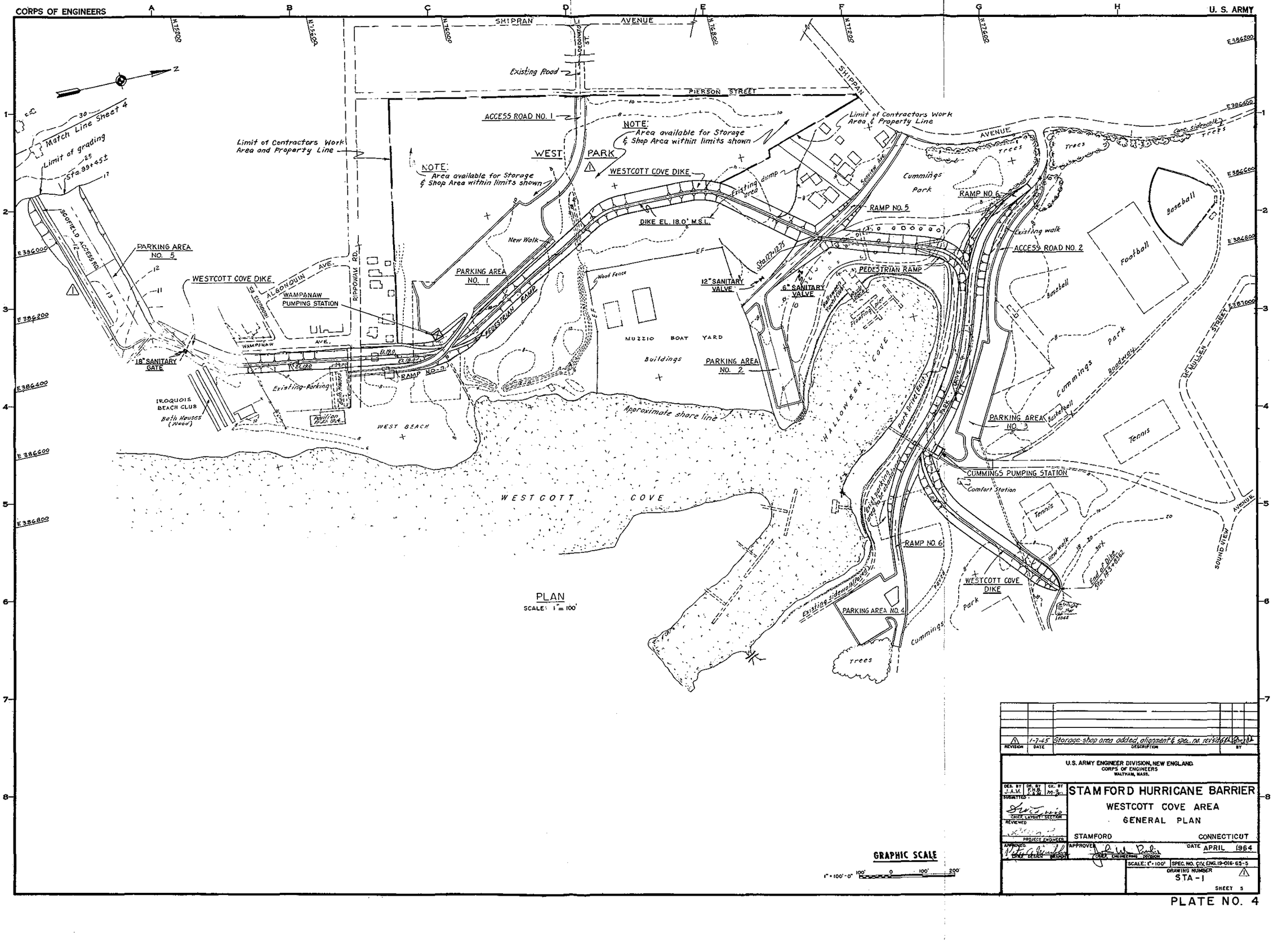
SCALE: AS SHOWN | SPEC. NO. CIV. ENG. 19-016-65-5

DRAWING NUMBER STA-1 (1)

SHEET 4

PLATE NO. 3

CORPS OF ENGINEERS — U. S. ARMY



PLAN
SCALE: 1" = 100'

GRAPHIC SCALE
1" = 100'-0" 100' 0 100' 200'

REVISION	DATE	DESCRIPTION	BY
1	1-7-65	Storage-shop area added, alignment & spe. no. revised	[illegible]

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.A.M. | DR. BY F.H.B. | CK. BY M.J.
SUBMITTED
CHIEF, LAYOUT SECTION
REVIEWED
PROJECT ENGINEER
APPROVED
CHIEF, DESIGN BRANCH
APPROVED
CHIEF, ENGINEERING DIVISION
DATE APRIL 1964

STAMFORD HURRICANE BARRIER
WESTCOTT COVE AREA
GENERAL PLAN

STAMFORD CONNECTICUT

SCALE: 1" = 100' | SPEC. NO. CIV. ENG. 19-016-65-5
DRAWING NUMBER STA-1
SHEET 5

PLATE NO. 4

N

N.Y.

MASS.

CONN.

R.I.

MERRIMACK RIVER

HAVERHILL

LOWELL

FITCHBURG

CONNECTICUT RIVER

HOLYOKE

SPRINGFIELD

WORCESTER

BOSTON

MASSACHUSETTS BAY

PROVINCETOWN

WOONSOCKET

FOX POINT (Completed)

WINSTED

HARTFORD

NEW LONDON (Under Construction)

PROVIDENCE

TAUNTON

CAPE COD BAY

CAPE COD CANAL

FALL RIVER

NEW BEDFORD

HOUSATONIC RIVER

WATERBURY

CONNECTICUT

NORWICH

PAWCATUCK (Completed)

THAMES R.

BUZZARDS BAY

NANTUCKET SOUND

NEWPORT

NEW HAVEN

NEW LONDON

NEW BEDFORD–FAIRHAVEN (Completed)

BRIDGEPORT

BLOCK ISLAND SOUND

CONN N.Y.

LONG ISLAND SOUND

BLOCK ID.

NORWALK

WESTERLY (Authorized)

STAMFORD

STAMFORD (Completed)

LONG ISLAND

NEW YORK

ATLANTIC OCEAN

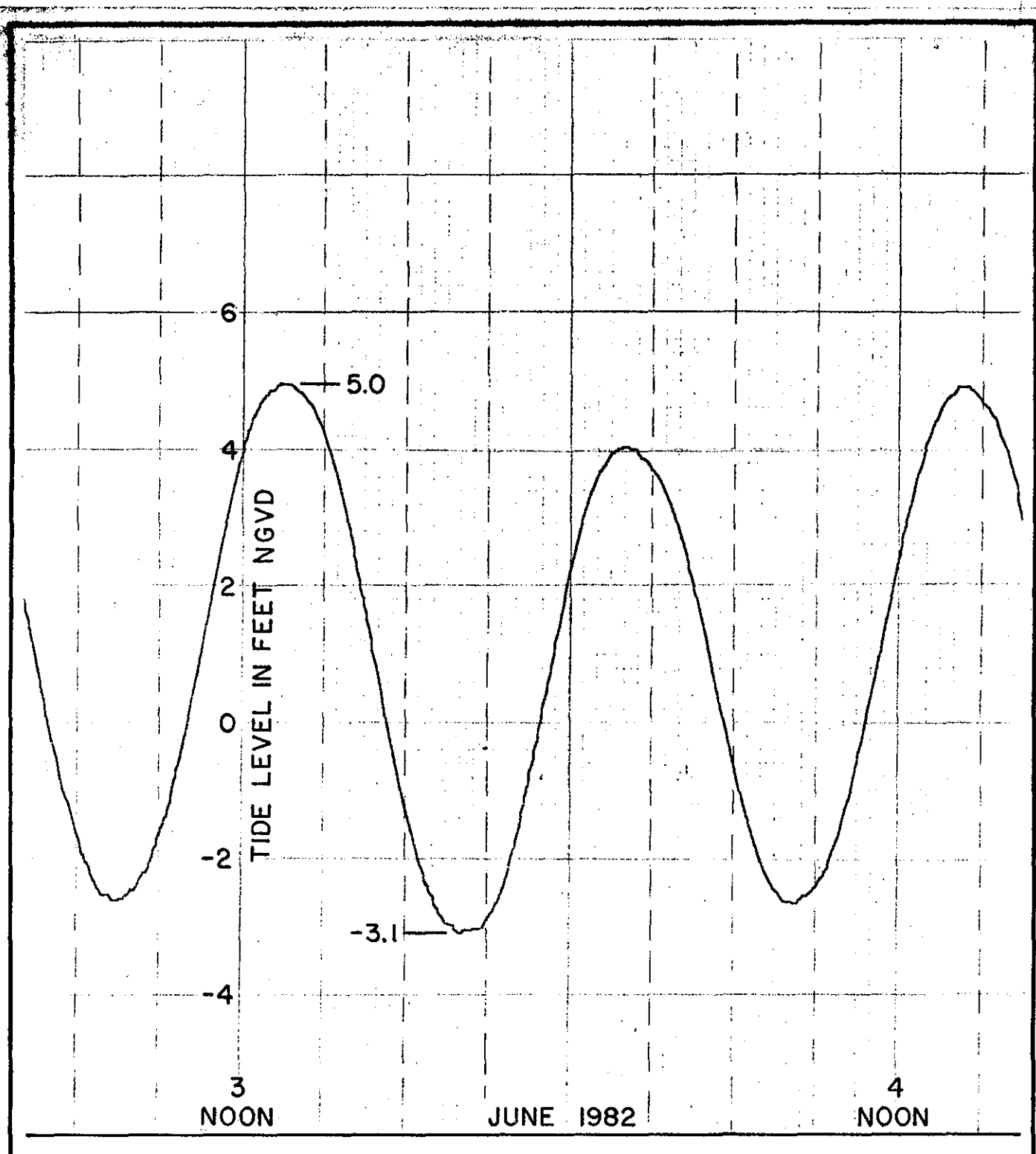
HURRICANE PROTECTION

LOCATIONS AND STATUS OF AUTHORIZED HURRICANE PROTECTION PROJECTS IN SOUTHERN NEW ENGLAND

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

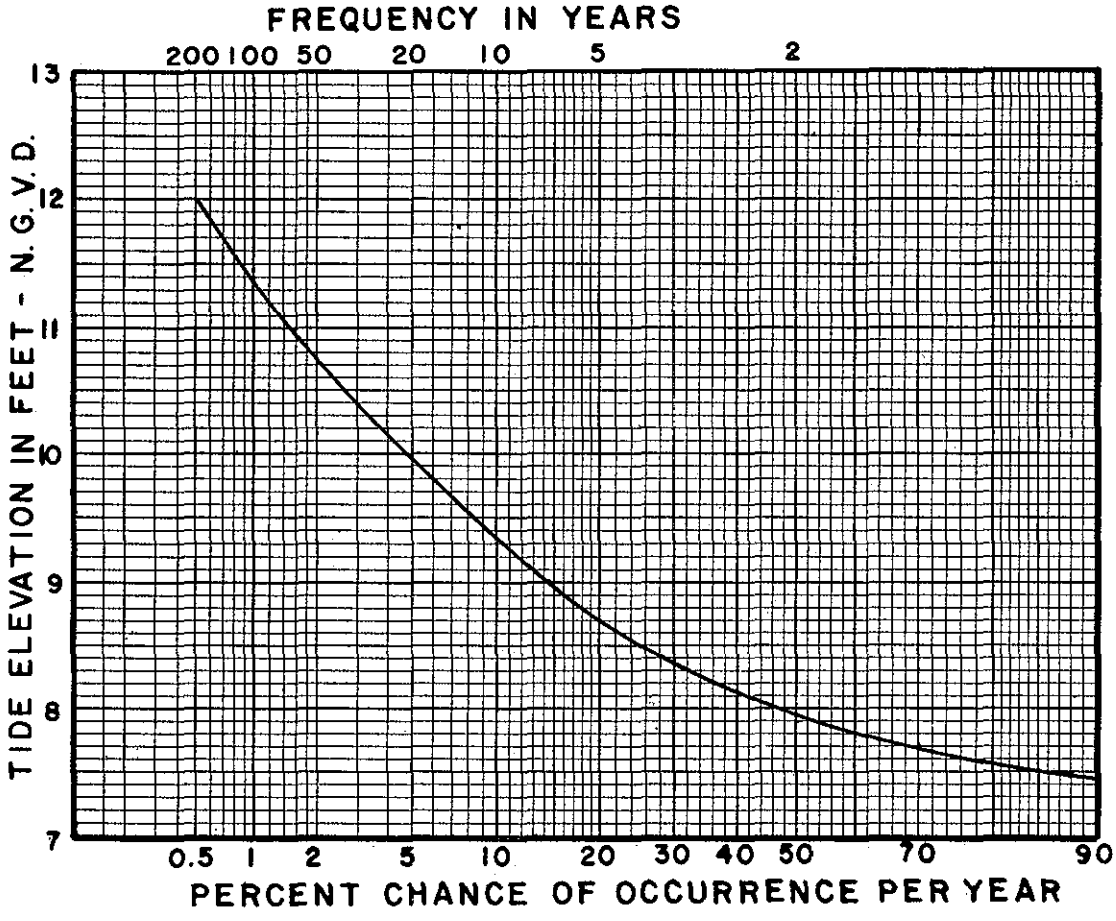
AUGUST 1982

PLATE 5



SAMPLE TIDE CHART
FOR
STAMFORD HARBOR

PLATE 6



Notes

1) Tidal Frequency Curve Prepared by Hydraulics and Water Quality Section.

2) Refer to Table 3 for Tabulation of Storm Tide Elevations Above 7.5 Ft.

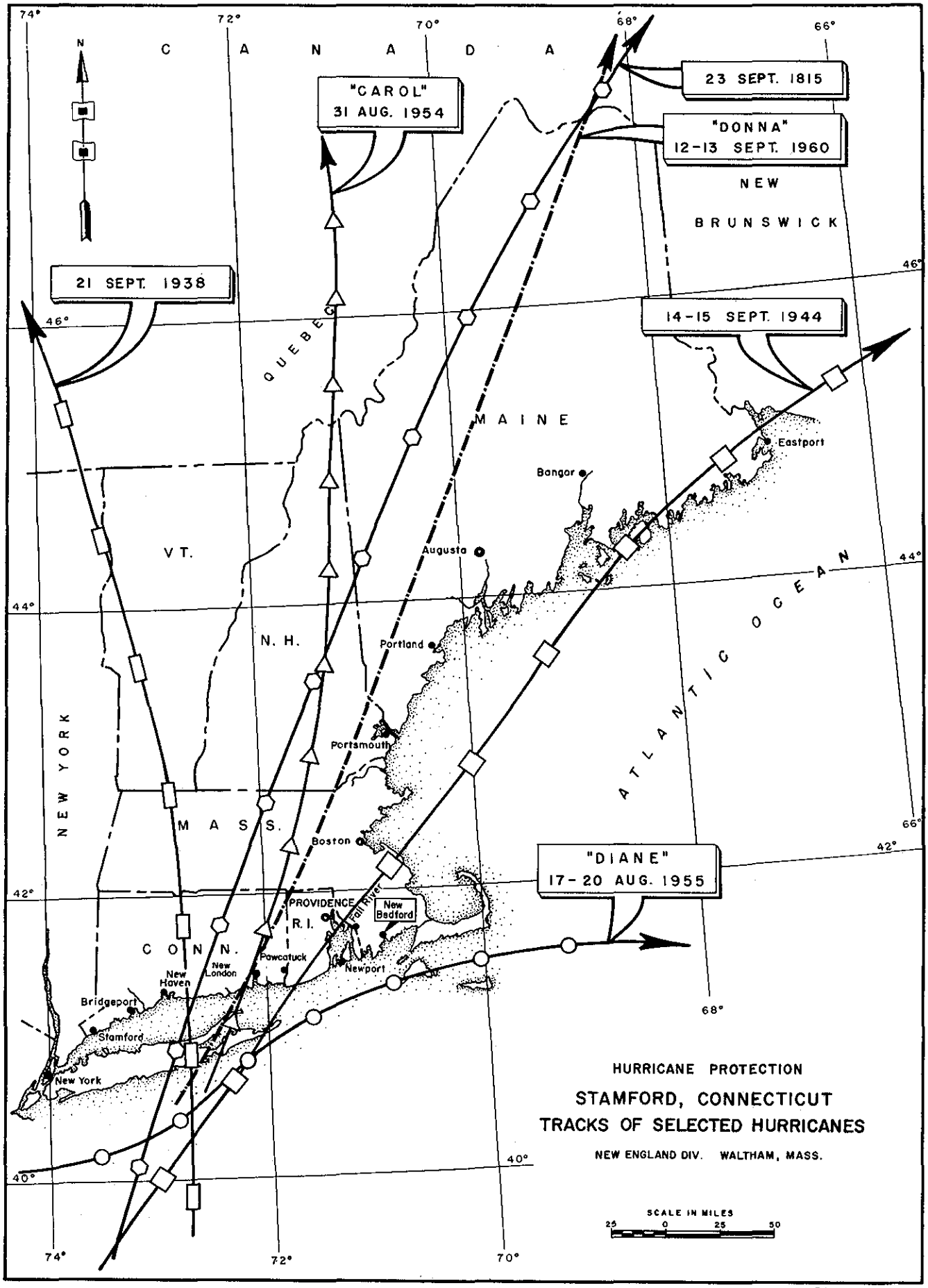
STAMFORD HURRICANE BARRIER

FREQUENCY OF TIDAL FLOODING

STAMFORD, CONNECTICUT

SEPT. 1982

PLATE 7



HURRICANE PROTECTION

STAMFORD, CONNECTICUT

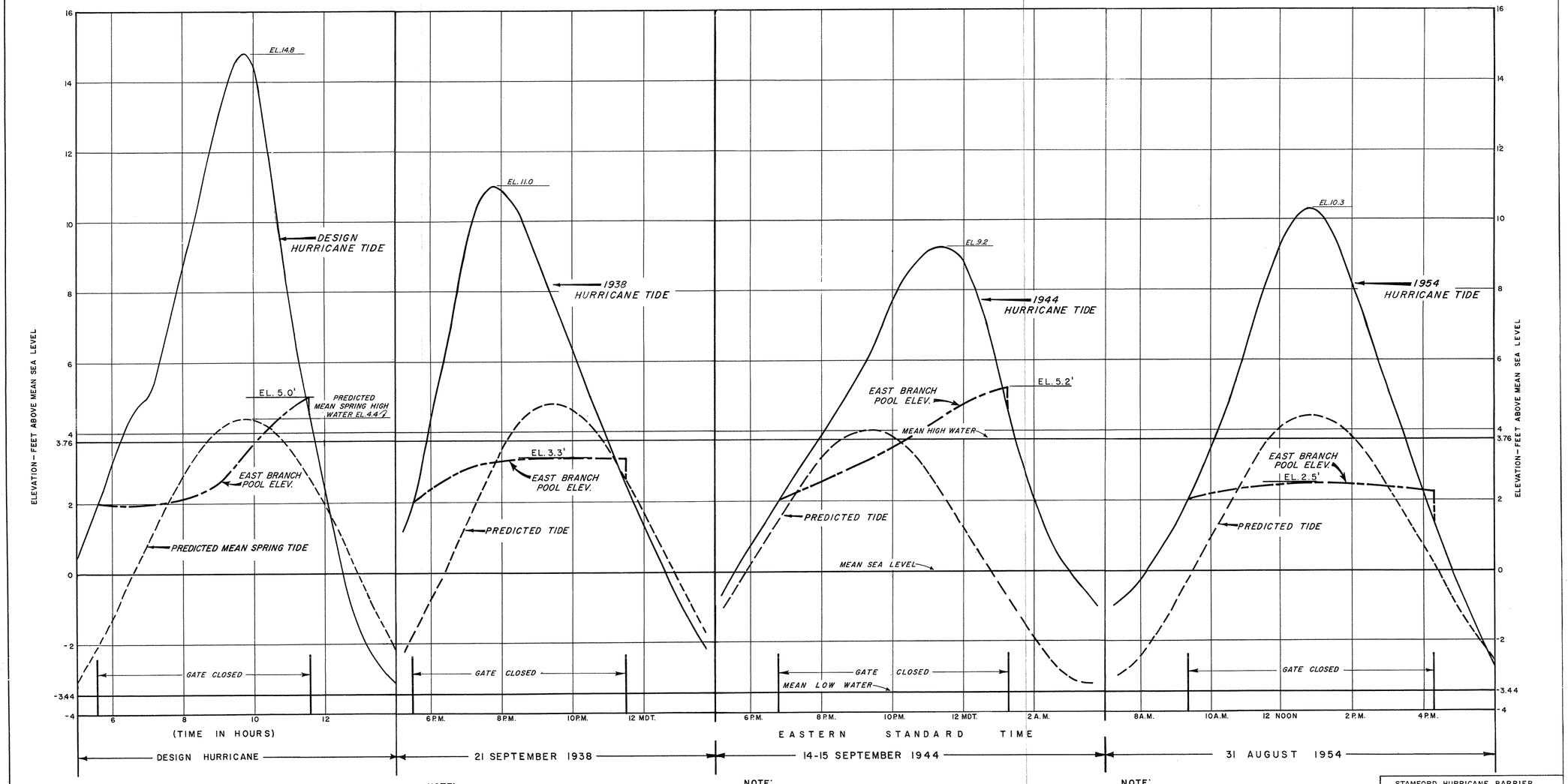
TRACKS OF SELECTED HURRICANES

NEW ENGLAND DIV. WALTHAM, MASS.

SCALE IN MILES

25 0 25 50

PLATE NO. 8



NOTE:

Design hurricane tide curve based on Texas A. & M. surge calculations for a design storm with a track most critical to Long Island Sound and with the peak of the surge coincident with the peak of a predicted mean spring tide.
East Branch pool elevation based on 10 year frequency storm runoff coincident with design tide.

NOTE:

Hurricane of September 21, 1938 tide curve based on high water marks at Stamford and hurricane tide at Willets Point, N.Y. and Bridgeport, Conn., stage related to Stamford.
East Branch pool elevation based on estimated runoff from hourly rainfall recorded at Mineola, New York.

NOTE:

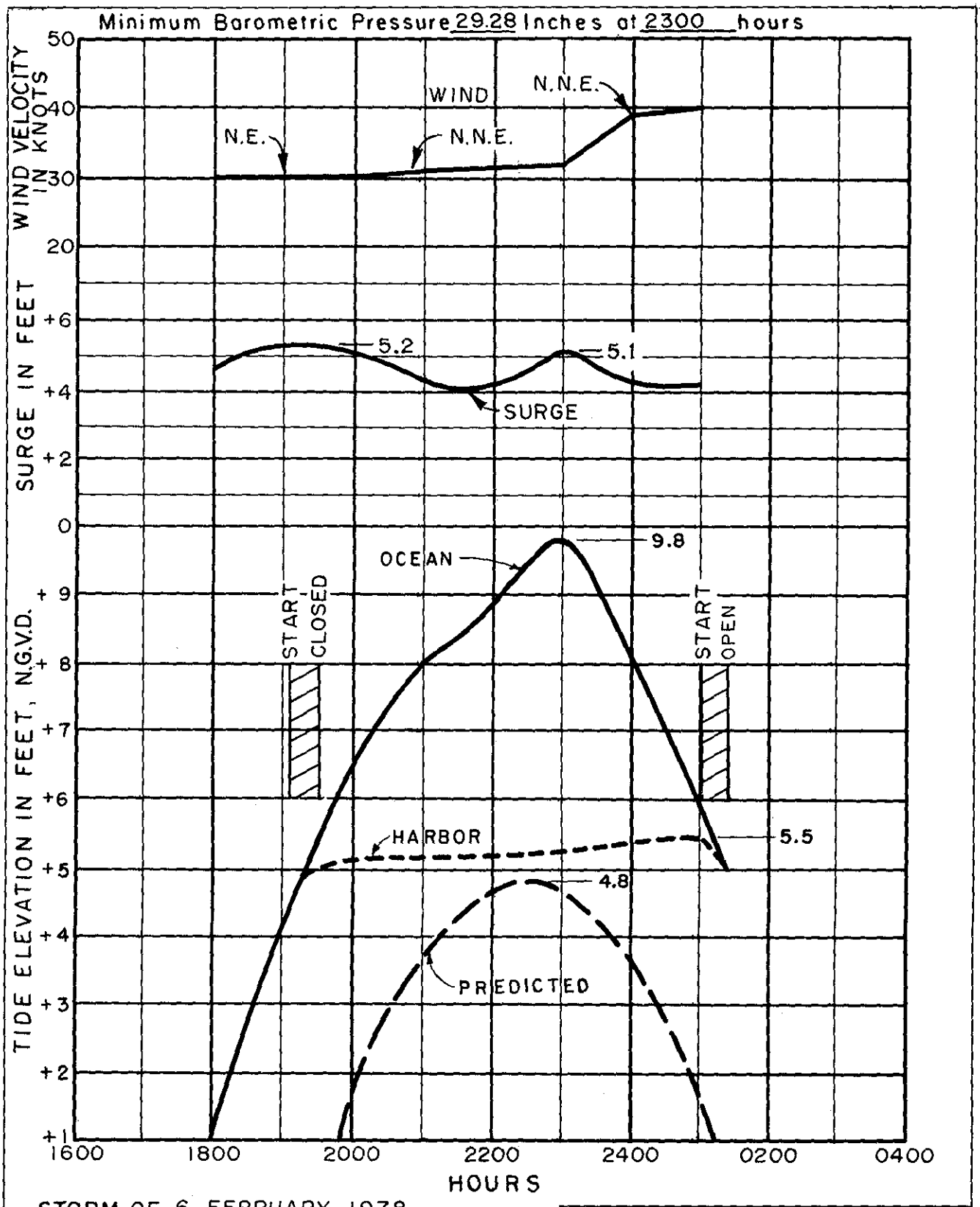
Hurricane of September 14-15, 1944 tide curve based on hurricane tide at Bridgeport, Conn. and New London, Conn., stage related to Stamford.
East Branch pool elevation based on peak 1938 hurricane storm runoff coincident with hurricane tide.

NOTE:

Hurricane Carol, August 31, 1954 tide curve based on high water marks at Stamford and hurricane tide at Bridgeport, Conn. and New London, Conn., stage related to Stamford.
East Branch Pool elevation based on estimated runoff from hourly rainfall recorded at Bridgeport, Conn.

STAMFORD HURRICANE BARRIER
STAMFORD, CONNECTICUT
OPERATION FOR
DESIGN, 1938, 1944, & 1954 HURRICANES
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. MARCH 1968

PLATE NO. 9



STORM OF 6 FEBRUARY 1978

NAVIGATION GATE

One 35' high, 94' wide
Bottom elev. -18 feet, N.G.V.D.
Gated channel opening, 90 feet
Gated by-pass conduit, 8' x 8'

M.H.W. = +3.8' N.G.V.D.
M.L.W. = -3.4' N.G.V.D.

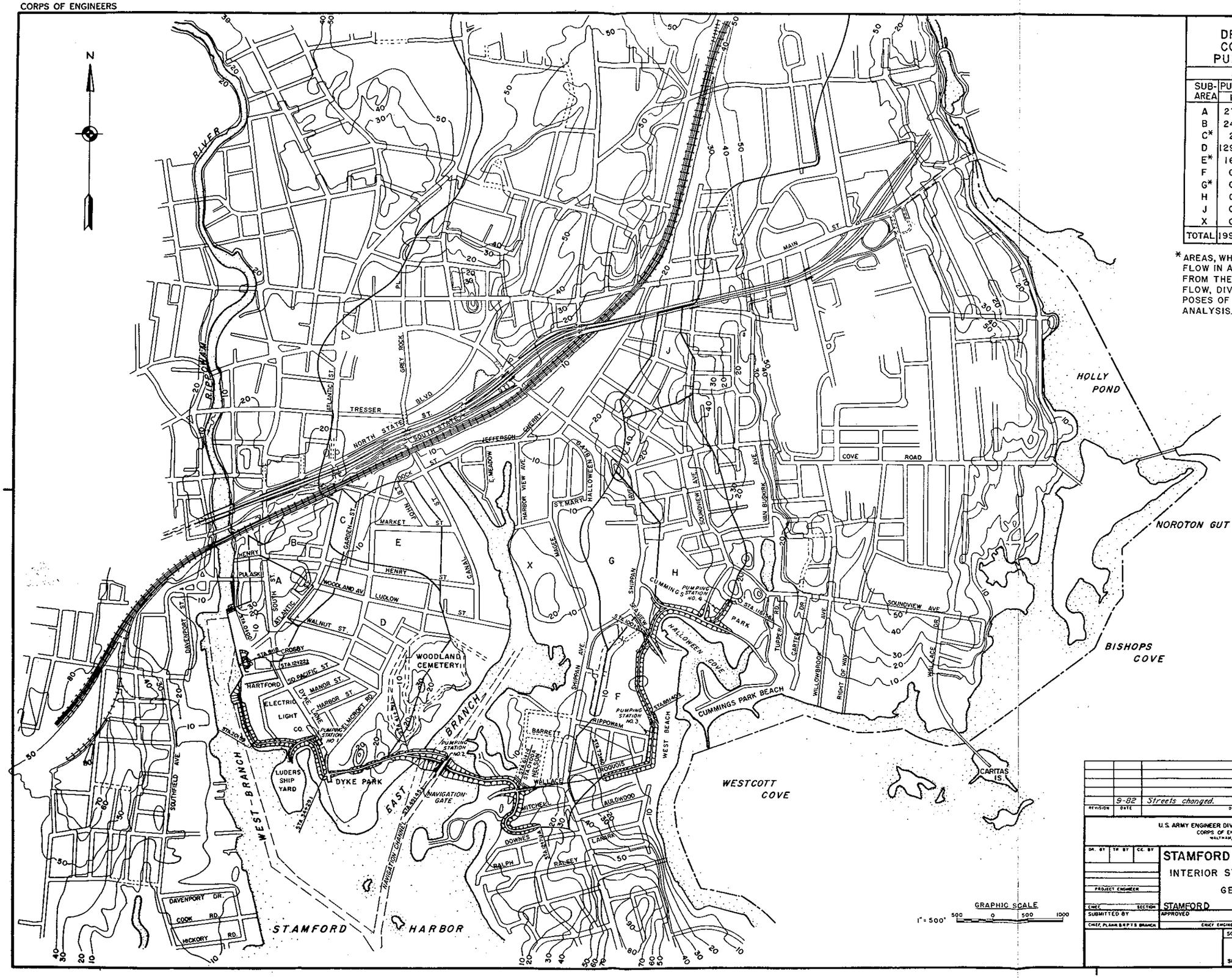
STAMFORD
HURRICANE PROTECTION PROJECT
CONNECTICUT
TIDAL BARRIER OPERATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE 10

CORPS OF ENGINEERS

U. S. ARMY



DRAINAGE AREAS CONTRIBUTING TO PUMPING STATIONS

SUB-AREA	AREAS IN ACRES PUMPING STATION NO. 2				TOTAL
	1	2	3	4	
A	27.9	0	0	0	27.8
B	24.6	0	0	0	24.6
C*	2.3	2.3	0	0	4.6
D	129.0	0	0	0	129.0
E*	16.1	16.1	0	0	32.2
F	0	0	38.7	0	38.7
G*	0	21.3	0	21.3	42.6
H	0	0	0	80.8	80.8
J	0	10.3	0	10.3	20.6
X	0	1156.0	0	0	1156.0
TOTAL	199.9	1206.0	38.7	112.4	1557.0

* AREAS, WHEREIN THE STORM DRAINS FLOW IN A DIRECTION DIFFERENT FROM THE NATURAL OVERLAND FLOW, DIVIDED EQUALLY FOR PURPOSES OF PUMPING STATION ANALYSIS.

GRAPHIC SCALE
1" = 500' 500 0 500 1000

REVISION	DATE	DESCRIPTION	BY
	9-82	Streets changed.	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR BY | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANN & RPTS BRANCH

STAMFORD HURRICANE BARRIER
INTERIOR STORM DRAINAGE AREAS
GENERAL PLAN

STAMFORD CONNECTICUT

APPROVED DATE OCT. 1962

CHIEF ENGINEERING DIV.

SCALE 1" = 500' | SPEC. NO. CIV ENG.-19-016-

DRAWING NUMBER

SHEET

PLATE 11

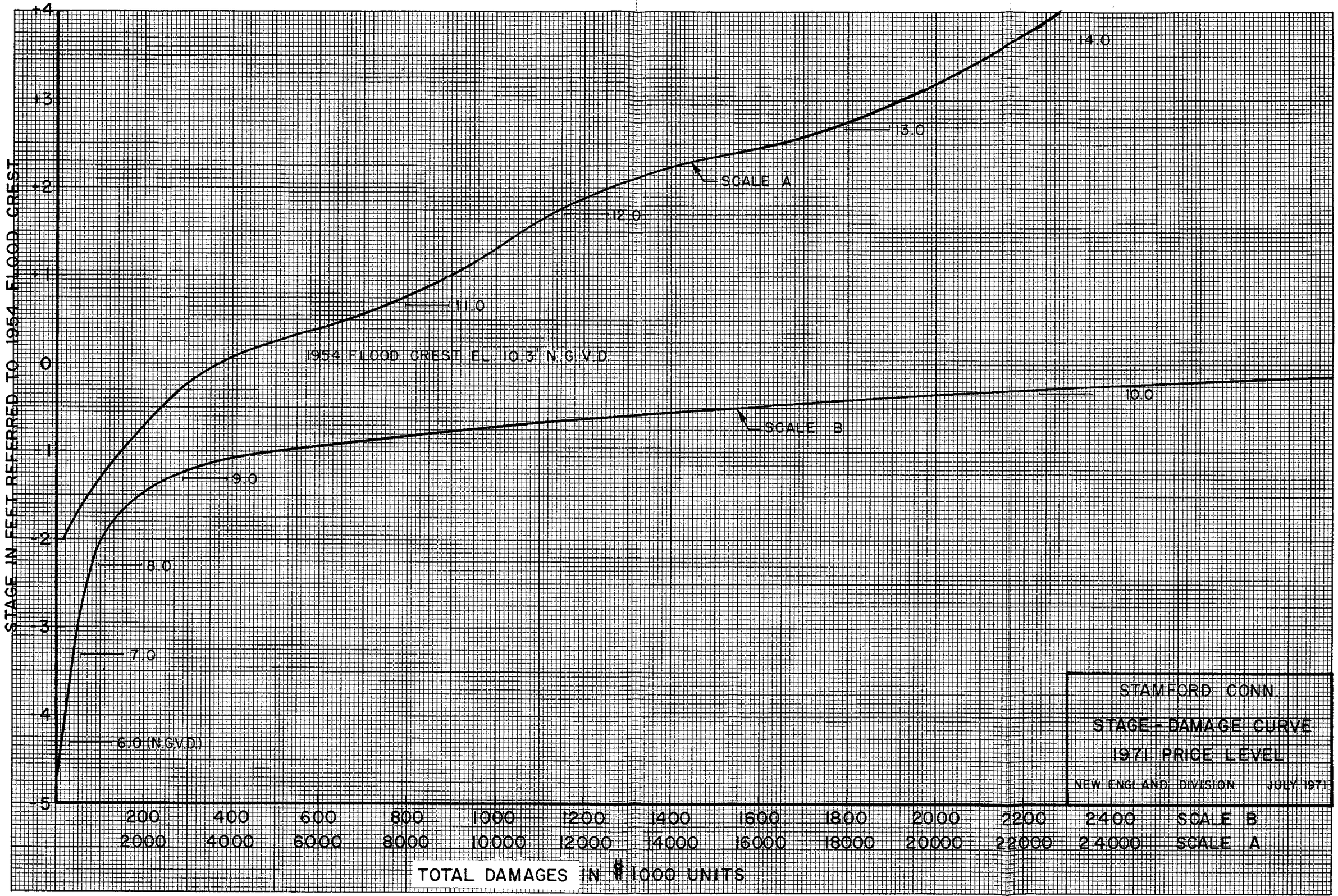
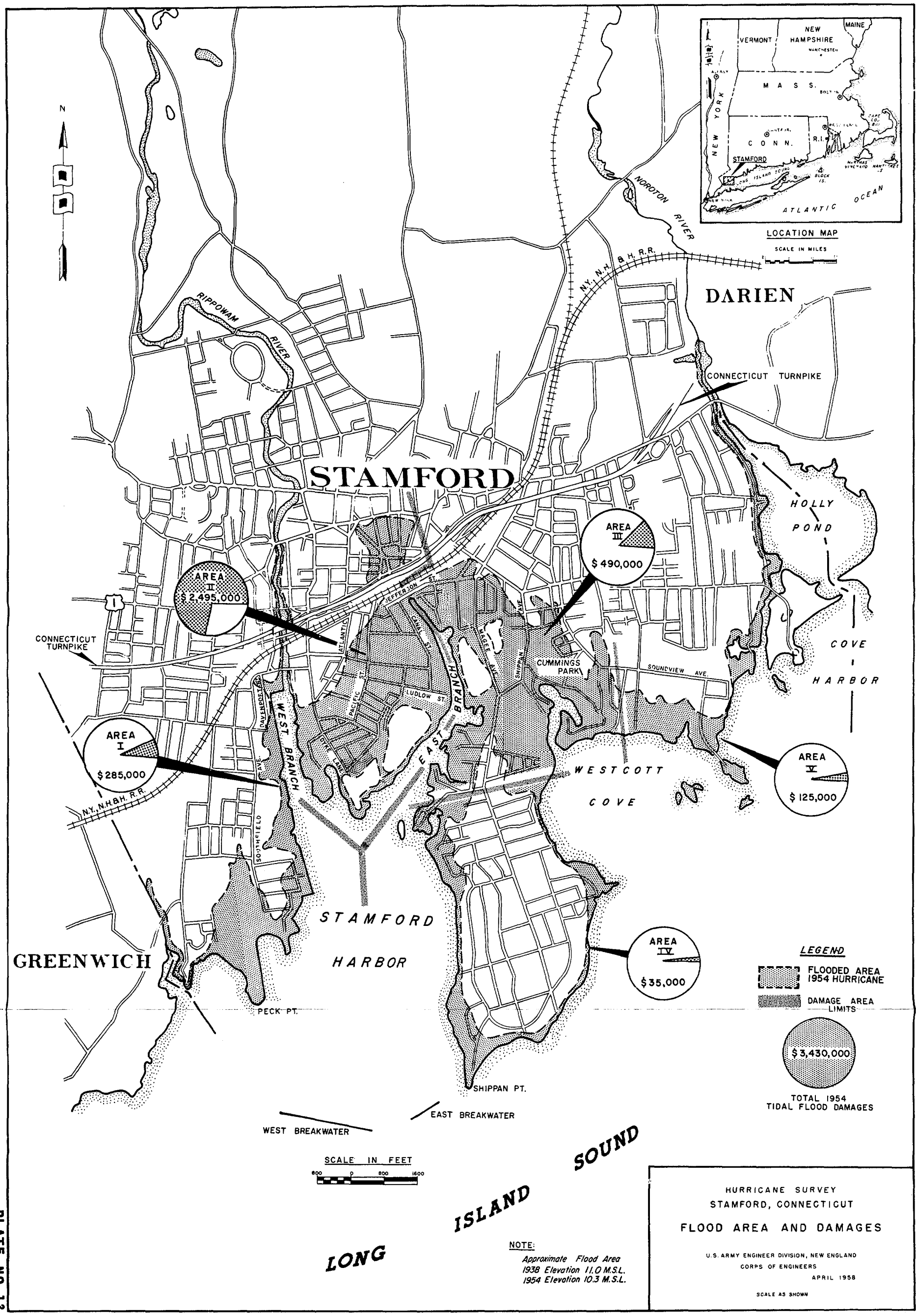

STAGE IN FEET REFERRED TO 1954 FLOOD CREST
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
14.0
13.0
SCALE A
12.0
11.0
1954 FLOOD CREST EL. 10.3' N.G.V.D.
10.0
SCALE B
9.0
8.0
7.0
6.0 (N.G.V.D.)
200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 SCALE B
2000 4000 6000 8000 10000 12000 14000 16000 18000 20000 22000 24000 SCALE A
TOTAL DAMAGES IN $1000 UNITS
STAMFORD CONN.
STAGE - DAMAGE CURVE
1971 PRICE LEVEL
NEW ENGLAND DIVISION JULY 1971

PLATE 12


N
RIPPOWAM
RIVER
NORTON RIVER
N.Y. N.H. & H. R.R.
DARIEN
CONNECTICUT TURNPIKE
STAMFORD
HOLLY POND
COVE HARBOR
AREA II $2,495,000
AREA III $490,000
AREA I $285,000
AREA V $125,000
AREA IV $35,000
JEFFERSON ST.
ATLANTIC
CANAL ST.
MAGEE AVE.
SHIPPAN
CUMMINGS PARK
SOUNDVIEW AVE.
LUDLOW ST.
PACIFIC ST.
DAVENPORT AVE.
SOUTHFIELD AVE.
WEST BRANCH
EAST BRANCH
WESTCOTT COVE
STAMFORD HARBOR
GREENWICH
PECK PT.
SHIPPAN PT.
EAST BREAKWATER
WEST BREAKWATER
LONG ISLAND SOUND
LOCATION MAP
SCALE IN MILES
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
MASS.
CONN.
R.I.
STAMFORD
ATLANTIC OCEAN
BLOCK IS.
LEGEND
FLOODED AREA 1954 HURRICANE
DAMAGE AREA LIMITS
$3,430,000
TOTAL 1954 TIDAL FLOOD DAMAGES
SCALE IN FEET
800 0 800 1600
NOTE:
Approximate Flood Area
1938 Elevation 11.0 M.S.L.
1954 Elevation 10.3 M.S.L.
HURRICANE SURVEY
STAMFORD, CONNECTICUT
FLOOD AREA AND DAMAGES
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
APRIL 1958
SCALE AS SHOWN
PLATE NO. 13

AERIAL VIEW OF
STAMFORD HARBOR

PLATE 14

A P P E N D I X A

CORPS OF ENGINEERS
STANDARD OPERATING PROCEDURES

APPENDIX A

TABLE OF CONTENTS

APPENDIX A

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A-2	Organization Chart - Reservoir Regulation
A-3	Tracks of Major Hurricanes and Areas of Operational Phases
A-4	Standard Operating Procedures
A-5	Operating Guide for Coastal Storms
A-6	Bulletins Concerning Operation of Navigation Gate
A-7	Time Conversion Table
A-8	East Branch Traffic Control System
A-9	Bypass Conduit Rating Curves
A-10	Area and Capacity Curves - East Branch
A-11	East Branch Pumping Station Log
A-12	Log of Reports - Hurricane Barrier Project
A-13	Tide Predictions - Daily High and Low Tides
A-14	Predicted Hourly Tide Heights

APPENDIX A

STAMFORD HURRICANE BARRIER STANDARD OPERATING PROCEDURE (SOP) FOR HURRICANES AND COASTAL STORMS

A-01. General. Emphasis in this Appendix is placed on duties of the Reservoir Control Center (RCC) and project manager for the operation of the navigation gate and East Branch pumping station for abnormal high tides during storms and hurricanes.

Operational procedures during regulation periods (see SOP charts on plate A-4) are divided into "phases" to assure delineation of responsibilities and actions to be taken by RCC and the project manager as a hurricane or coastal storm approaches New England. Plate A-6 contains various bulletins required during different phases of hurricane or coastal storm operations.

A-02. Regulation for Hurricanes. Refer to plate A-3 for "Alert", "Watch" and "Warning" phases.

a. Phase 1 - Alert. National Weather Service (NWS) announces that a hurricane poses a possible threat to southern New England, or its center is located north of 27^{0} latitude and west of 67^{0} longitude.

(1) RCC will alert Corps and Stamford barrier personnel, and arrange to receive further advisories from NWS.

(2) RCC and the project manager will plot position and movement of hurricane.

b, Phase 2 - Watch. Hurricane "Watch" announced by NWS for southern New England coast or hurricane center crosses 35^{0} latitude and is possibly headed for New England.

(1) RCC will activate regulation personnel in NED and request staffing of barrier.

(2) Personnel at the barrier will test equipment needed for hurricane operation.

(3) Project manager will advise city officials that the barrier is staffed.

(4) Project manager will observe conditions at the project and report information to RCC (a sample is shown on plate A-12).

(5) RCC will request project manager to issue advisory

to the Coast Guard (bulletin 3) and transmit appropriate telephone recorded bulletin for public information.

(6) RCC will discuss proposed regulation procedures with the project manager in case of communication problems during the hurricane.

c. Phase 3 - Warning. Hurricane "Warning" announced by NWS or hurricane center crosses 38° latitude and is still moving towards southern New England.

(1) RCC will request project manager to issue bulletin 3 to the Coast Guard concerning time of probable gate operation, and provide appropriate telephone recorded bulletin.

(2) The project manager will continue reporting project conditions to RCC as requested.

d. Phase 4 - Tidal Surge. Rising hurricane tide is commencing and approaching 2.0+ NGVD or starting to rise before the ocean level recedes to 2.0 feet from the previous tide cycle.

(1) The project manager will initiate warning signals 10 minutes before scheduled start of closure. Strobeacons at Jacks Island and Lindstrom Point will be increased from 3 to 30 flashes per minute. Three minutes prior to closure the horn and red neon signs reading "CLOSED" will be turned on and checked at the barrier. The horn will stop automatically when the gate is fully closed in upright position 20 minutes later (10 minutes should be allowed to raise gate to water surface and 10 additional to complete navigation gate closure).

(2) RCC will instruct project manager to start closing procedures for the navigation gate, and start pumps at the East Branch pumping station when rainfall is occurring. Notify RCC when closure is completed. The pumping station operation log is shown on plate A-11.

Considerable discretion is necessary in initiating closure if approaching vessels are only a short distance from the barrier and will be passing through within 2 or 3 minutes. The ocean elevation and rate of rise must be considered in delaying closure for marine traffic. The project manager should be in communication with RCC during this sensitive phase of the operation if vessels are approaching.

(3) RCC will request project manager to issue an appropriate bulletin to the Coast Guard and prepare a telephone recorded bulletin concerning gate closure.

e. Phase 5 - Cessation. Ocean tide level has receded to harbor elevation and is falling.

(1) RCC will instruct project manager to open navigation gate and cease pumping operations.

NOTE: Opening of the gate should be initiated early enough so the harbor elevation will not exceed the falling ocean elevation by more than one-half foot during the opening period.

(2) The project manager will turn on the horn before opening the navigation gate. The horn will continue until the gate is fully open, then shut off automatically. The neon lights will be switched to "OPEN"; the strobeacons will revert back to three flashes per minute. The operator will check to make sure the above items have changed and a complete log of operations has been maintained.

(3) If the hurricane moves away and is no longer a threat to the Stamford area, RCC will direct personnel to demobilize. However, if it appears the tides again may be above normal, RCC may continue staffing of the barrier.

(4) RCC will request project manager to issue appropriate bulletin to the Coast Guard, and prepare a recorded telephone bulletin concerning gate opening.

(5) Complete the operation log and prepare a report.

A-03. Regulation for Coastal Storms

a. Phase 1 - Alert. National Weather Service announces that a storm system poses a high tide threat to southern New England, or RCC determines weather conditions warrant an alert.

(1) RCC will alert project manager of staffing time and probable operating tide level (in case of communication failure).

(2) RCC will contact NWS for further storm advisories.

b. Phase 2 - Watch. Based on NWS forecasts and observed conditions at the project, it is expected the incoming tide will exceed operating levels (see plate A-5, Operating Guide for Coastal Storms).

(1) East Branch barrier is staffed.

(2) Project manager will record and transmit observations of tides and weather data to Reservoir Control Center as requested.

(3) RCC will: (a) plot the surge, observed and predicted tides, (b) record meteorological and tide data, (c) analyze tide and weather data and estimate time for start of navigation gate closure.

(4) RCC will request project manager to issue an advisory to the Coast Guard when gate closure is expected (bulletin 2), and prepare appropriate recorded telephone message for public information.

c. Phase 3 - Operation. Tide approaches established level for start of gate closure.

(1) RCC will instruct project manager to close the navigation gate and, if necessary, start pumps due to rainfall.

(2) Time permitting, early notification of closure should be made to allow project manager to have the strobeacons at Jacks Island and Lindstrom Point increased from 3 to 30 flashes per minute (10 minutes prior to scheduled start of gate closure). Three minutes prior to closure the horn and red neon signs reading "CLOSED" will be turned on at the barrier and checked. The horn will stop automatically when the gate is fully closed in an upright position 20 minutes later.

Considerable discretion must be used in initiating closure if approaching vessels are only a short distance from the barrier and will be passing through within 2 or 3 minutes. The ocean elevation and rate of rise must be considered in delaying closure for marine traffic. The project manager should be in communication with RCC during this sensitive phase of the operation if vessels are approaching.

(3) The Reservoir Control Center will instruct project manager to issue appropriate advisory to the Coast Guard concerning gate closure, and prepare appropriate recorded telephone bulletin.

(4) Reservoir Control Center will continue to log data reported by the project manager.

d. Phase 4 - Cessation. Ocean tide level has receded to harbor elevation and is falling.

(1) RCC will instruct project manager to open navigation gate and cease operations.

NOTE: Opening of the gate should be initiated early enough so the harbor elevation will not exceed the falling ocean elevation by more than one-half foot during the opening period.

(2) The project manager will turn on the horn before opening the navigation gate. The horn will continue to operate and will shut off automatically when the gate is fully open. The neon lights will be switched to "OPEN" and the strobeacons will revert back to 3 flashes per minute. The project manager will check to make sure the above items have changed and a complete log of operations has been maintained.

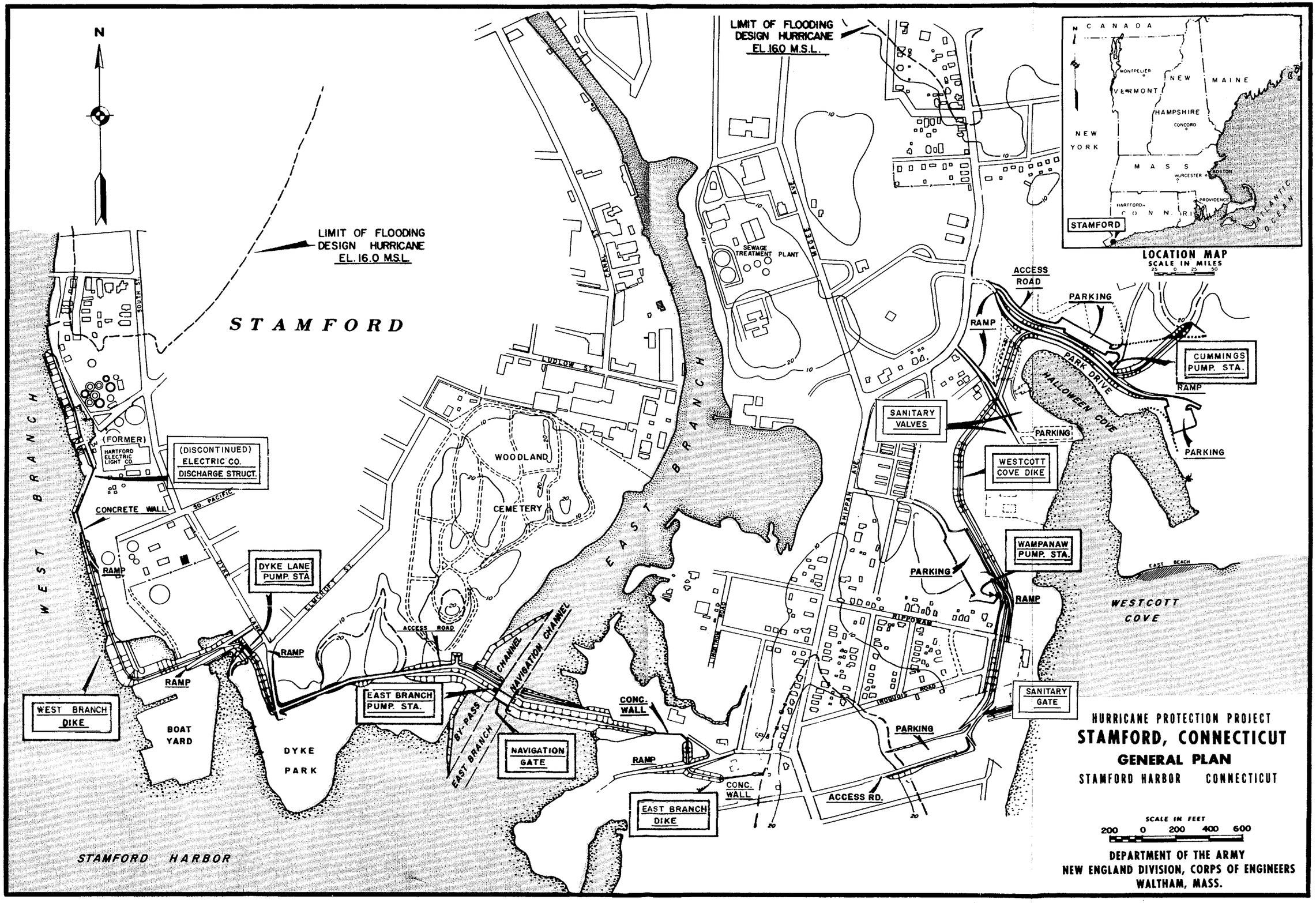
(3) Reservoir Control Center may direct personnel to demobilize when the threat of high tides has receded.

(4) RCC will instruct operator to issue an appropriate bulletin to the Coast Guard and prepare a recorded telephone bulletin concerning gate opening.

A-04. Emergency Operating Procedure

a. Failure of Communications. In the event the project manager is unable to communicate with RCC by normal or emergency methods during phase 3 procedures for a hurricane or coastal storm, the operator has full authority and responsibility to operate the project according to a guide and procedures shown on plates A-4 and A-5.

b. Gate Inoperable. If at any time the East Branch navigation gate is inoperable, Operations Division will notify the city of Stamford. If the gate is inoperable during an operation, Reservoir Control Center will immediately notify the city of the situation and of possible consequences. If the gate becomes inoperable in a closed or partially closed position, the project manager will operate the bypass gate and/or pumps as directed by RCC.



HURRICANE PROTECTION PROJECT

STAMFORD, CONNECTICUT

GENERAL PLAN

STAMFORD HARBOR CONNECTICUT

SCALE IN FEET
200 0 200 400 600

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE NO. A-1

WATER CONTROL BRANCH
L. BERGEN CHIEF

RESERVOIR CONTROL CENTER
J. FINEGAN, CHIEF

HOUSATONIC RIVER BASIN
R.W. MIRICK BASIN REGULATOR

- THOMASTON DAM — A. HOFFMAN, PROJ. MGR. / R. M. HOWE, ASSISTANT
- HALL MEADOW BROOK DAM *
- EAST BRANCH DAM *
- NORTHFIELD BROOK LAKE
- HANCOCK BROOK LAKE
- HOP BROOK LAKE — L. WILLIAMS, PROJ. MGR. / J. DELONG, ASSISTANT
- BLACK ROCK LAKE — E.W. FOSTER, PROJ. MGR. / J. COLLINS, ASSISTANT

CONNECTICUT RIVER BASIN
N. FORBES, BASIN REGULATOR

- UNION VILLAGE DAM — R. THRESHER, PROJ. MGR. / G PARKER, ASSISTANT
- NORTH HARTLAND LAKE — J. DYER, PROJ. MGR. / G. WHEELER, ASSISTANT
- NORTH SPRINGFIELD LAKE — T. COEN, PROJ. MGR. / T. SNOW, ASSISTANT
- BALL MOUNTAIN LAKE — R. SNOW PROJ. MGR.
- TOWNSHEND LAKE — R. BALLANTINE, PROJ. MGR.
- SURRY MOUNTAIN LAKE — V. GUYETTE, PROJ. MGR. / P. MORRISON, ASSIST
- OTTER BROOK LAKE — J. BOYEA, PROJ. MGR. / D. SHEPARDSON, ASSISTANT
- BIRCH HILL DAM — J. BACON, PROJ. MGR. / J. COLBY, ASSISTANT
- TULLY LAKE — G. BARTLETT, PROJ. MGR.
- BARRE FALLS DAM — C. SABINE PROJ. MGR.
- CONANT BROOK DAM
- LITTLEVILLE LAKE — J. PARKER, PROJ. MGR. / M. CAPUTO, ASSISTANT
- KNIGHTVILLE DAM — J. JOHNSON, PROJ. MGR. / H. THOMAS, ASSISTANT
- COLEBROOK RIVER LAKE — P.R. LEWIS, PROJ. MGR. / D. GREENE, ASSISTANT
- MAD RIVER DAM *
- SUCKER BROOK DAM *

THAMES RIVER BASIN
T.D. BUCKELEW, BASIN REGULATOR

- MANSFIELD HOLLOW LAKE — W. HAWTHORNE, PROJ. MGR. / D. WARREN, ASSISTANT
- BUFFUMVILLE LAKE — R. TETREAULT, PROJ. MGR. / R. FREYTAG, ASSISTANT
- HODGES VILLAGE DAM — PROJ. MGR. / E. GLASS, ASSISTANT
- EAST BRIMFIELD LAKE — L. J. ROBERTS, PROJ MGR
- WESTVILLE LAKE — W.T. SMITH, PROJ. MGR. / R.J. TRYBA, ASSISTANT
- WEST THOMPSON LAKE — C.A. BUSWELL, PROJ. MGR.

BLACKSTONE RIVER BASIN
T.D. BUCKELEW, BASIN REGULATOR

- WEST HILL DAM — J. FINNERTY, PROJ. MGR.

MERRIMACK RIVER BASIN
R.W. MIRICK, BASIN REGULATOR

- FRANKLIN FALLS DAM — O. LAROCHE, PROJ. MGR. / J. PARENTEAU, ASSIST.
- BLACKWATER DAM — J. ROBERTS, PROJ. MGR.
- EDWARD MACDOWELL DAM — J. RATHBURN, PROJ. MGR. / K.B. WETHERBEE, ASSIST.
- HOPKINTON LAKE — R.A. GOLEC, PROJ. MGR. / E.P. MCCABE, ASSISTANT
- EVERETT LAKE — J.A. PLIFKA, PROJ. MGR. / W. TURNER, ASSISTANT

HURRICANE BARRIERS
J. FINEGAN REGULATOR

- NEW BEDFORD BARRIER — J.J. ARRUDA, PROJ. MGR.
- STAMFORD BARRIER — J. BAUKUS PROJ. MGR.
- FOX POINT BARRIER — ADVISORIES TO PROVIDENCE R.I. PUBLIC WORKS DEPT.

* Maintained By State Of Connecticut, Department of Environmental Protection, Water and Related Resources Unit

RCC ASSISTANTS
P.E. HETU

WCB ASSISTANTS
T. M. BARKER
D. L. WILSON
C. J. WENER
O. L. DONATI
D. G. WOOD
T. M. GEIB
P. J. MARINELLI
R. P. MICHIELLUTTI

ORGANIZATION CHART FOR RESERVOIR REGULATION

DIVISION ENGINEER
ENGINEERING DIVISION
WATER CONTROL BRANCH
RESERVOIR CONTROL CENTER

BASIN MANAGERS	
R MORGAN	HOUSATONIC R. BASIN
J. CLARKIN	THAMES R. BASIN
J. W. WARD	MERRIMACK R. BASIN
M. CURRAN	CONN. R. BASIN (UPPER)
J. LEDGERE	CONN. R. BASIN (LOWER)

ORGANIZATION CHART

RESERVOIR REGULATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SEPTEMBER 1982

PLATE A-2

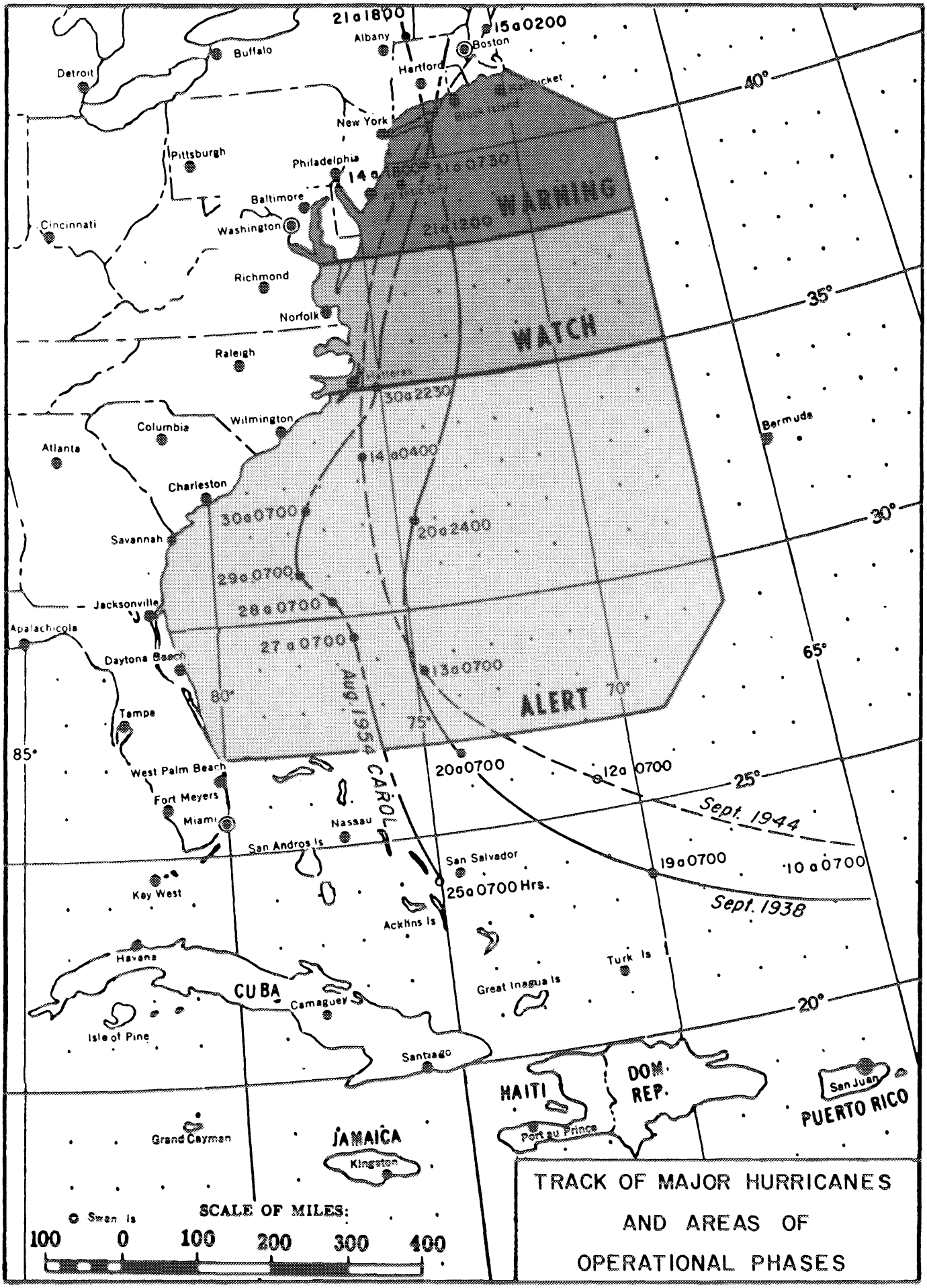

21 a 1800
15 a 0200
Albany
Boston
Buffalo
Detroit
Hartford
New York
Pittsburgh
Philadelphia
Baltimore
Washington
Cincinnati
Richmond
Norfolk
Raleigh
Columbia
Wilmington
Atlanta
Charleston
Savannah
Jacksonville
Apalachicola
Daytona Beach
Tampa
West Palm Beach
Fort Meyers
Miami
Key West
Havana
CUBA
Camaguey
Isle of Pine
Santiago
Grand Cayman
JAMAICA
Kingston
Swan Is
Nassau
San Andros Is
San Salvador
Acklins Is
Great Inagua Is
Turk Is
HAITI
Port au Prince
DOM. REP.
San Juan
PUERTO RICO
Bermuda
WARNING
WATCH
ALERT
40°
35°
30°
25°
20°
65°
70°
75°
80°
85°
21 a 1200
30 a 2230
14 a 0400
30 a 0700
20 a 2400
29 a 0700
28 a 0700
27 a 0700
13 a 0700
20 a 0700
12 a 0700
19 a 0700
10 a 0700
25 a 0700 Hrs.
Aug. 1954
CAROL
Sept. 1944
Sept. 1938
SCALE OF MILES:
100 0 100 200 300 400
TRACK OF MAJOR HURRICANES
AND AREAS OF
OPERATIONAL PHASES

PLATE A-3

CORPS OF ENGINEERS U. S. ARMY

STANDARD OPERATING PROCEDURE

EAST BRANCH NAVIGATION GATE & PUMPING STATION
STAMFORD, CONNECTICUT

COASTAL STORMS

PHASE I ALERT

CONDITIONS	PROCEDURAL DUTIES
1. National Weather Service (N.W.S.) Forecasts Abnormal Tides Which May Require Operation At Stamford Or Reservoir Control Center (R.C.C.) Determines Conditions Warrant An Alert.	1. R.C.C. Will Alert Project Manager Of Starting Time And Probable Operating Tide Level. 2. R.C.C. Will Contact N.W.S. For Further Advisories.

PHASE II WATCH

CONDITIONS	PROCEDURAL DUTIES
1. Based On N.W.S. Forecasts And Observed Conditions At Stamford. It Is Expected That The Incoming Tide Will Exceed Operating Levels Shown On Plate A-5.	1. East Branch Barrier Is Staffed. 2. Barrier Operater Will Record And Transmit Observations Of Tides And Weather Data To R.C.C. As Requested. 3. R.C.C. Will: (a) Plot, Record And Analyze Data (b) Determine Start Of Gate Closure. 4. R.C.C. Will Request Operater To Issue Bulletin # 2.

PHASE III OPERATION

CONDITIONS	OPERATIONS
1. Tide Approaches Established Level For Start Of Gate Closure.	1. Activated Traffic Warning System. 2 Check Channel For Boats, Start Closure Of Navigation Gates, 3. Notify R.C.C. When Gate Closure Is Complete And If Necessary Start East Branch Pumps. 4. R.C.C. Will Instruct Operator To Issue Advisory To U.S.C.G. (Bulletin # 4)

PHASE IV CESSATION

CONDITIONS	OPERATIONS
1. Tide Recedes To Bay Elevation And Falling. 2. Storm No Longer Threat To Area.	1 Open Navigation Gate, And Stop Pumps. 2. Check Traffic Warning System When Gate Is Completely Down. 3. R.C.C. Will Instruct Operator To Issue Advisory To U.S.C.G. (Bulletin # 1) 4. Complete Log Of Operations.

HURRICANES

PHASE I ALERT

CONDITIONS	PROCEDURAL DUTIES
1. National Weather Service (N.W.S.) Announces That A Hurricane Off The Atlantic Coast Poses A Possible Threat To Southern New England And/Or Its Center Is Located North Of 27° Latitude And West Of 67° Longitude.	1. R.C.C. Will Alert Personnel For Possible Staffing. 2 R.C.C. Will Arrange To Receive Further Advisories From N.W.S. And Plot Storm Movements.

PHASE II WATCH

CONDITIONS	PROCEDURAL DUTIES
1. Hurricane "Watch" Announced By N. W. S. For Southern New England Coast And /Or Hurricane Crosses 35° Latitude And Is Possibly Headed For New England.	1. Operator Will Staff Navigation Barrier and Notify City. 2. Operator Will Test Navigation Gate And E. Branch Pumps. 3. Operator Will Report Observations And Data To R.C.C. As Requested. 4. R.C.C. Will Instruct Operator To Issue Advisory To U.S.C.G. (Bulletin # 3).

PHASE III WARNING

CONDITIONS	OPERATIONS
1. Hurricane "Warning" Announced By N. W. S. For Southern New England Coast And/or Hurricane Crosses 38° Latitude And is Still Moving Towards Southern New England.	1. Full Complement Of Corps Personnel Mobilized. 2. Operator Will Continue To Report Project Conditions to R. C. C. As Requested. 3. R. C. C. Will Instruct Operator To Issue Advisory To U. S. C. G. (Bulletin # 3).

PHASE IV SURGE

CONDITIONS	OPERATIONS
1. Rising Hurricane Tide Is Commencing And Approaching + 2.0' N. G. V. D.	1. Activate Traffic Warning System. 2. R. C. C. Will Instruct Operator To Start Closure Procedures For Navigation Gate and, If Raining, Start Pumps. 3. Notify R. C. C. When Gate Closure is Complete. 4. R. C. C. Will Instruct Operator To Issue Advisory To U. S. C. G. (Bulletin # 5).

PHASE V CESSATION

CONDITIONS	OPERATIONS
1. Tide Recedes To Harbor Elevation And Falling 2. Hurricane No Longer Threat To Area.	1. Open Navigation Gate, And Stop Pumps. 2. Turn Off Traffic Warning System When Gate Is Completely Open. 3. R.C.C. Will Instruct Operator To Issue Advisory To U.S.C.G. (Bulletin # 1). 4. Demobilize If Tides Have Returned To Normal. 5. Complete Log Of Operations And Prepare Report.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY M.W.B. | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF

STAMFORD HURRICANE PROJECT

STANDARD OPERATING PROCEDURE

EAST BRANCH NAVIGATION GATE AND PUMPING STATION

STAMFORD, CONNECTICUT

APPROVED DATE

CHIEF ENGINEERING DIVISION

SCALE:

DRAWING NUMBER

PLATE A-4

OPERATING GUIDE

FOR COASTAL STORMS

1. Nonfreezing Temperatures

   a. Dry conditions or negligible rainfall

      For tides of 6.2* feet or less - no operation

      When tides higher than 6.2 feet are expected, operate to keep harbor at or below 5.8

   b. Moderate rain

      When tides higher than 6.0 feet are expected, operate to keep harbor at or below 5.5

   c. Heavy rain

      When tides higher than 5.8 feet are expected, operate to keep harbor at or below 5.0

2. Freezing Temperatures (28^{o} or Lower)

   a. For tides of 6.0 feet or less - no operation

   b. When tides higher than 6.0 feet are expected, operate to keep harbor at or below 5.8

* Expected Tide = Predicted astronomical tide plus NWS surge forecast

BULLETINS CONCERNING OPERATION
OF STAMFORD NAVIGATION GATE
(To be Used on Telephone Tape Recorder
and Issued to US Coast Guard)

BULLETIN 1 - THE CORPS OF ENGINEERS ADVISES THAT THE NAVIGATION GATE AT THE STAMFORD BARRIER IS OPEN TO TRAFFIC. PLEASE USE CAUTION WHILE PASSING THROUGH THE BARRIER.

BULLETIN 2 - THE CORPS OF ENGINEERS ADVISES THAT DUE TO THREATENING HIGH TIDES THE NAVIGATION GATE AT THE STAMFORD BARRIER WILL (MAY) BE CLOSED ABOUT ____(Hour)____ HOURS (EST OR EDST) ON ____(Day)____, ____(Date)____.

BULLETIN 3 - THE CORPS OF ENGINEERS ADVISES THAT, IF HURRICANE (TROPICAL STORM) ____(Name)____ CONTINUES ON ITS PRESENT COURSE, IT WILL (MAY) BE NECESSARY TO CLOSE THE NAVIGATION GATE AT THE STAMFORD BARRIER ABOUT ____(Hour)____ HOURS (EST OR EDST) ON ____(Day)____, ____(Date)____. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.

BULLETIN 4 - THE CORPS OF ENGINEERS ADVISES THAT THE NAVIGATION GATE AT THE STAMFORD BARRIER IS CLOSED. THE ESTIMATED TIME OF OPENING WILL BE AT ____(Hour)____ HOURS (EST OR EDST) ON ____(Day)____, ____(Date)____. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.

BULLETIN 5 - THE CORPS OF ENGINEERS ADVISES THAT THE NAVIGATION GATE AT THE STAMFORD BARRIER IS CLOSED AND WILL REMAIN CLOSED UNTIL THE STORM HAS PASSED. MARINERS SHOULD BE ALERT FOR FURTHER ADVISORIES.

BULLETIN 6 - (Put on telephone tape recorder at barrier 24 hours before scheduled time of closure. Notify US Coast Guard a week before date of closure).

THE CORPS OF ENGINEERS ADVISES THAT THE NAVIGATION GATE AT THE STAMFORD BARRIER WILL BE CLOSED FOR A MAINTENANCE TEST BETWEEN ____(Hour)____ AND ____(Hour)____ HOURS (EST OR EDST) ____(Day)____, ____(Date)____.

BULLETIN 7 - (Any telephone recorded warning pertaining to special conditions while passing through the barrier, such as obstruction, fog, ice, wind, etc.)

TIME CONVERSION TABLE

Eastern Standard Time (EST)	Eastern Daylight Saving Time (EDT)	24-Hour Clock (EST)	24-Hour Clock (EDT)	Greenwich Civil Time (ZULU TIME)
7:00 P.M.	8:00 P.M.	1900	2000	2400Z 0000Z
8:00 P.M.	9:00 P.M.	2000	2100	0100Z
9:00 P.M.	10:00 P.M.	2100	2200	0200Z
10:00 P.M.	11:00 P.M.	2200	2300	0300Z
11:00 P.M.	12:00 Midnight	2300	2400	0400Z
12:00 Midnight	1:00 A.M.	2400	0100	0500Z
1:00 A.M.	2:00 A.M.	0100	0200	0600Z
2:00 A.M.	3:00 A.M.	0200	0300	0700Z
3:00 A.M.	4:00 P.M.	0300	0400	0800Z
4:00 A.M.	5:00 A.M.	0400	0500	0900Z
5:00 A.M.	6:00 A.M.	0500	0600	1000Z
6:00 A.M.	7:00 A.M.	0600	0700	1100Z
7:00 A.M.	8:00 A.M.	0700	0800	1200Z
8:00 A.M.	9:00 A.M.	0800	0900	1300Z
9:00 A.M.	10:00 A.M.	0900	1000	1400Z
10:00 A.M.	11:00 A.M.	1000	1100	1500Z
11:00 A.M.	12:00 Noon	1100	1200	1600Z
12:00 Noon	1:00 P.M.	1200	1300	1700Z
1:00 P.M.	2:00 P.M.	1300	1400	1800Z
2:00 P.M.	3:00 P.M.	1400	1500	1900Z
3:00 P.M.	4:00 P.M.	1500	1600	2000Z
4:00 P.M.	5:00 P.M.	1600	1700	2100Z
5:00 P.M.	6:00 P.M.	1700	1800	2200Z
6:00 P.M.	7:00 P.M.	1800	1900	2300Z

NOTE: Z time is five (5) hours ahead of Eastern Standard Time and four (4) hours ahead of Daylight Saving Time.

CORPS OF ENGINEERS — U. S. ARMY

GATE CHANNEL FLDLTS
GATE OPERATING HORN

"OPEN"-"CLOSED" SIGNS

TRAFFIC INDICATOR
PULSATING STROBEACON

LINDSTROM POINT

See Plan this sheet

EAST BRANCH PUMPING STATION

C.G. LIGHT FL. RED #968

EAST BRANCH DIKE

NAVIGATION GATE

DIKE PARK

C.G. LIGHT FL. GREEN #967

EAST BRANCH NAVIGATION CHANNEL

WARE ISLAND

PINE ISLAND

C.G. LIGHT FL. RED #966 (RANGE)

WEST BRANCH CHANNEL

C.G. LIGHT FL. GREEN #969

C.G LIGHT FL. WHITE #965 (RANGE)

TRAFFIC INDICATOR
PULSATING STROBEACON

JACKS ISLAND

See Plan this sheet

STAMFORD HARBOR

1 MILE

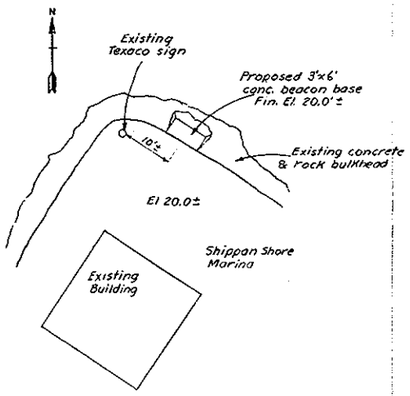
STAMFORD LIGHT FL. WHITE #962

C.G. LIGHT FL. GREEN #963

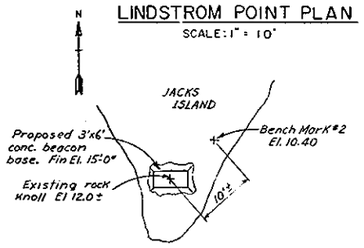
BREAKWATER

C.G. LIGHT FL. RED #964

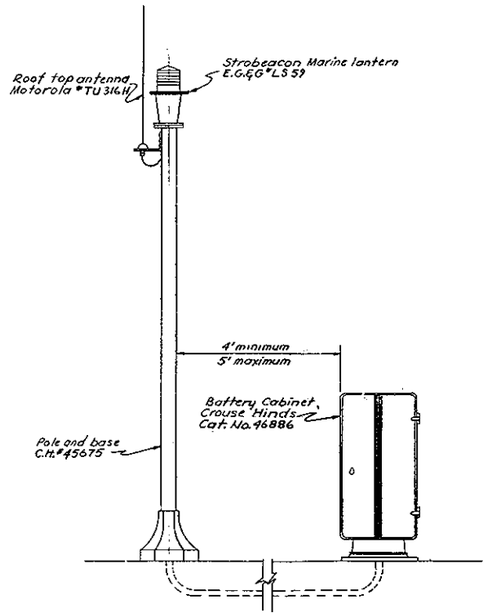
SITE PLAN
SCALE: 1"=200'



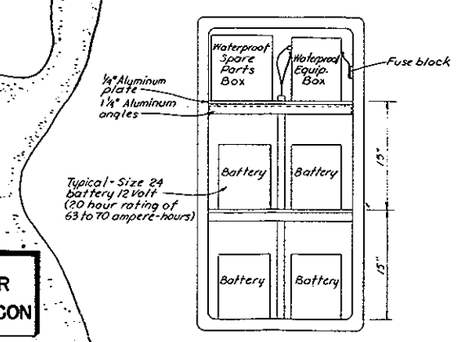
LINDSTROM POINT PLAN
SCALE: 1" = 10'



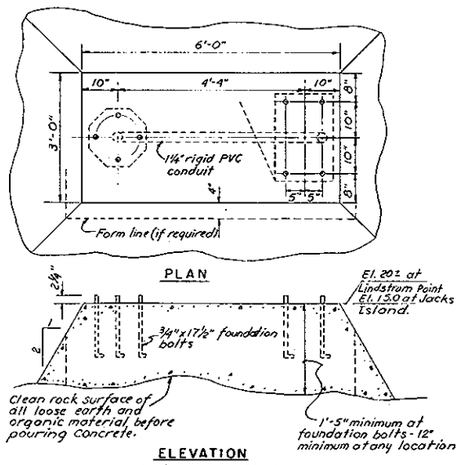
JACKS ISLAND PLAN
SCALE: 1" = 10'



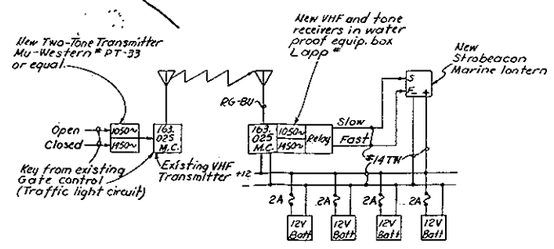
STROBEACON DETAIL
SCALE: 3/4" = 1'-0"



BATTERY CABINET
(INTERIOR VIEW)
SCALE: 1-1/2" = 1'-0"



ELEVATION
BASE DETAILS
SCALE: 3/4" = 1'-0"



BLOCK DIAGRAM
NOT TO SCALE

GRAPHIC SCALES

1" = 10'
1" = 200'
1-1/2" = 1'-0"
3/4" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
REVIEWED:
PROJECT ENGINEER
APPROVED:
CHIEF, DESIGN BRANCH

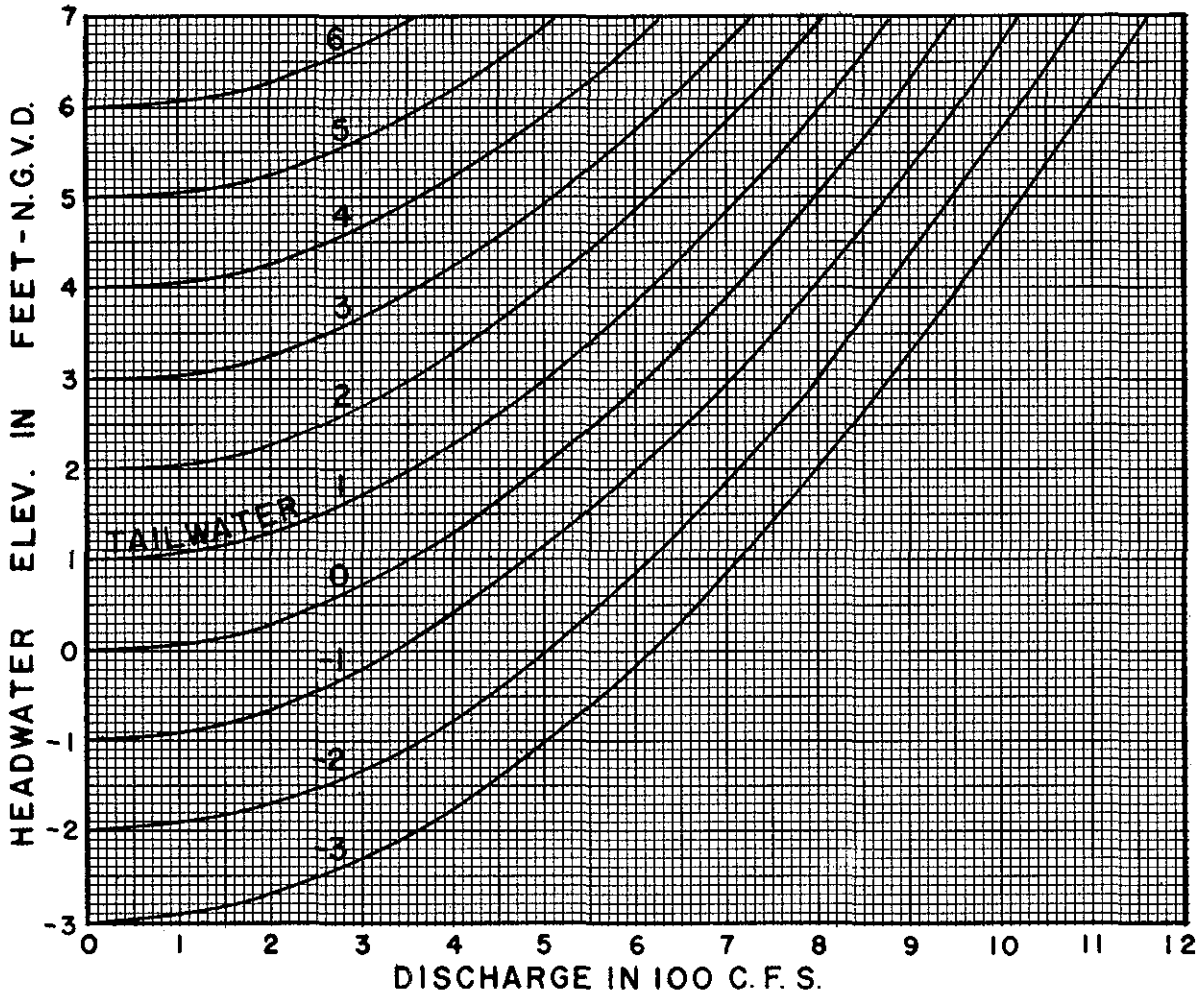
STAMFORD HURRICANE BARRIER
EAST BRANCH NAVIGATION GATE AND CHANNEL

TRAFFIC CONTROL SYSTEM
STAMFORD CONNECTICUT

APPROVED DATE MAY 1966
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE A-8



NOTES

1. 8 Ft. x 8 Ft. By-pass Sluice Gate Fully Open.
2. Invert Elev. - 13.0 Ft. N. G. V. D.

STAMFORD HURRICANE BARRIER

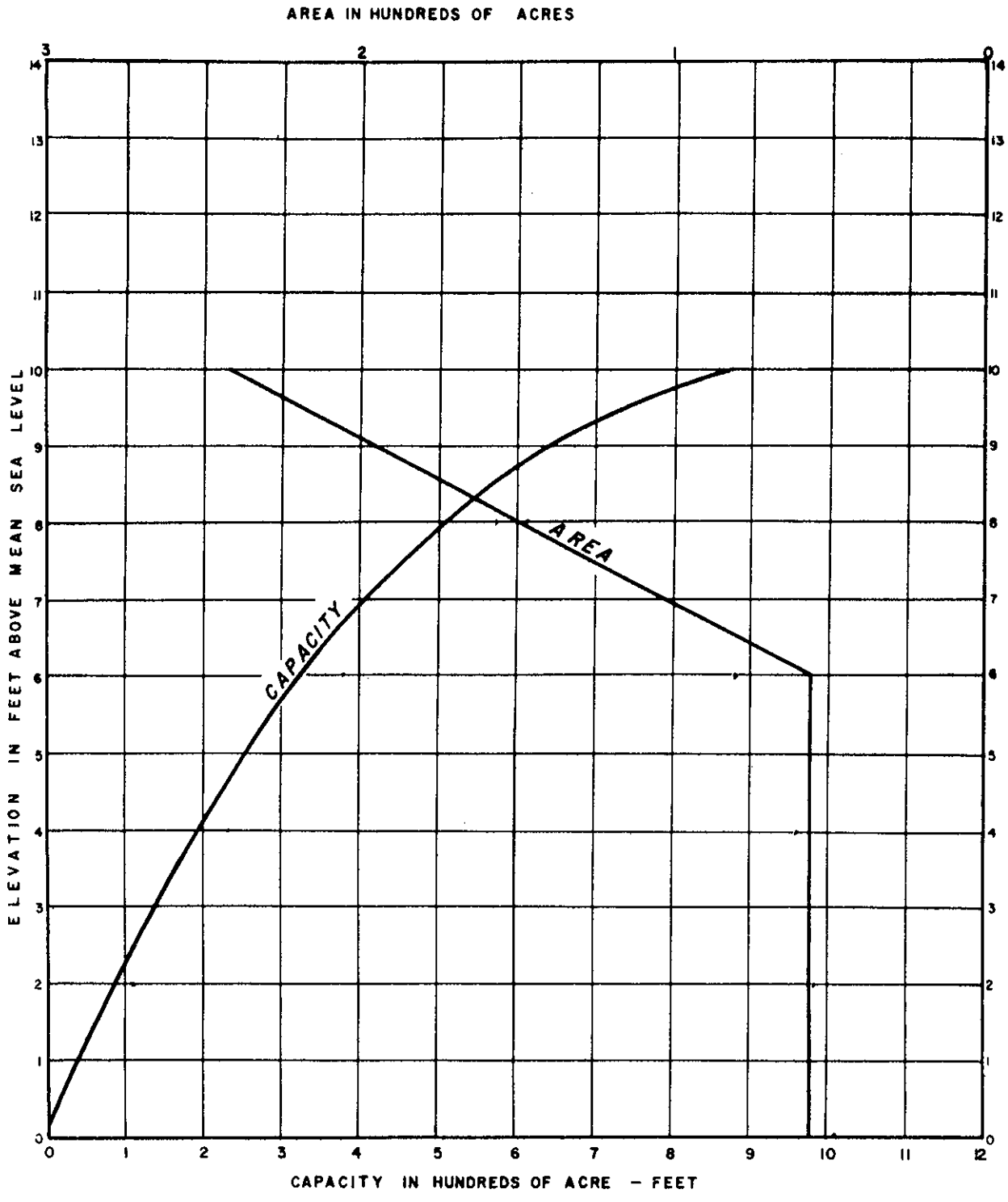
BY-PASS CONDUIT RATING CURVES

EAST BRANCH BARRIER

STAMFORD, CONNECTICUT

SEPTEMBER 1982

PLATE A-9



HURRICANE SURVEY

STAMFORD CONNECTICUT

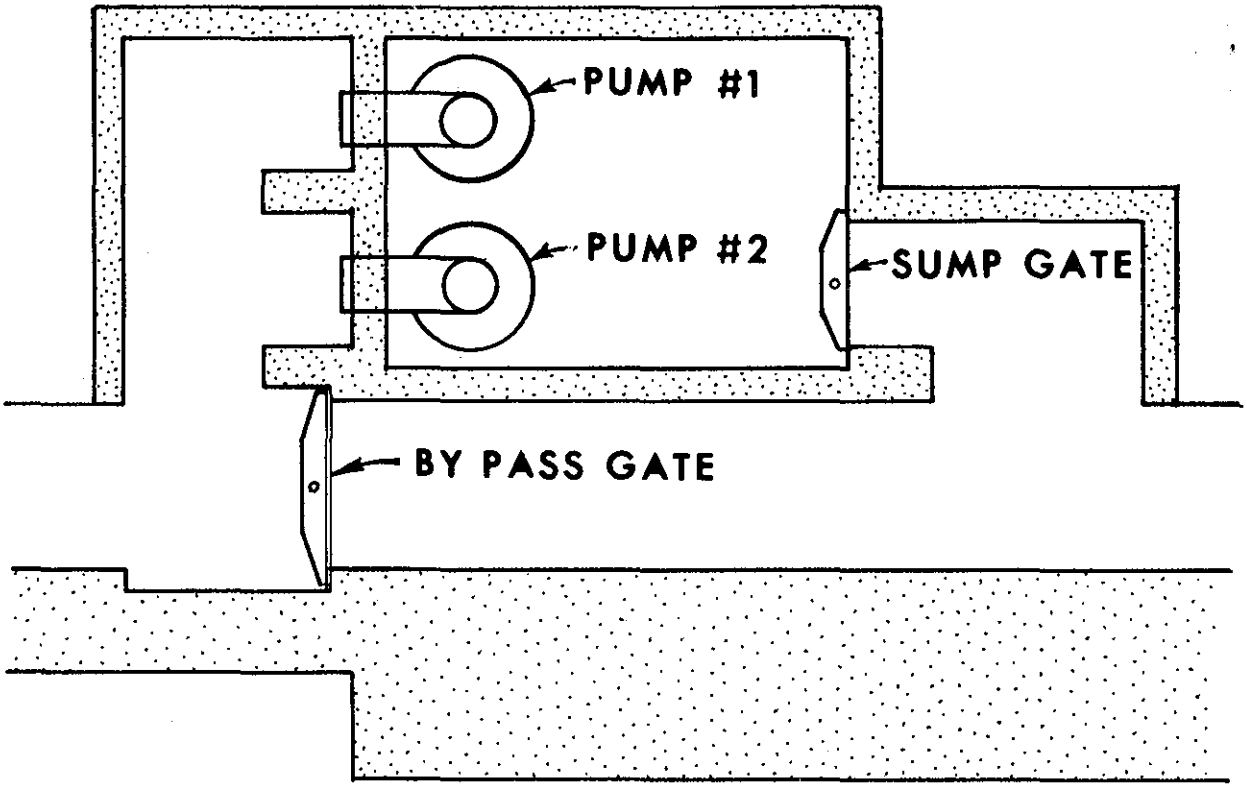
AREA AND CAPACITY CURVES

EAST BRANCH

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS

PLATE NO. A-10

EAST BRANCH
PUMPING STATION - OPERATION LOG



TIME	OCEAN EL.	HARBOR EL.	SUMP GATE	BY PASS GATE	PUMP #1	PUMP #2	REMARKS

PLATE A-II

LOG OF REPORTS STAMFORD HURRICANE BARRIER PROJECT

	METEOROLOGY						TIDE DATA		GATES				
1 DATE-TIME	2 PRECIP.-IN. (LAST 24-HRS.)	3 FORM OF PRECIPITATION	4 PRESENT WEATHER	5 WIND DIRECTION	6 WIND VELOCITY (K)	7 BAROMETRIC PRESSURE (IN.)	8 OCEAN EL. (FT.-M.S.L.)	9 HARBOR EL. (FT.-M.S.L.)	10 CONDUITS OPEN	10 CONDUITS CLOSED	11 SECTOR OPEN	11 SECTOR CLOSED	REMARKS AND/OR INSTRUCTIONS
10 JAN. 1977													SURGE
0900	0.65	SNOW TO RAIN	H.R.	ENE	GUSTS-34 18-22	29.50 ↓	+0.2	+0.2					3.6'- CALL AT 1000 HRS
1000	0.93	H.R.	H.R.	ENE	G-34 16-20	29.40 ↓	1.8	1.8					4.3'- Temp=36° CALL AT 1100 HRS
1100	1.20	H.R	H.R.	ENE	G-18 10-14	29.32 ↓	3.5	3.5					ISSUE BULLETIN #2 4.4'-START CLOSURE AT 4.5'±
1135							4.5	4.5					STARTED CLOSURE
1155							4.9	4.8					COMPLETED CLOSURE
1200	1.35	M.R.	L.R.	ENE	G-16 8-10	29.14 ↓	5.3	4.8					4.2'-T=36°F CALL AT 1300
1300	1.36	L.R.	L TO M.R.	ENE	8-10	29.08 (S)	6.8	5.1					3.8'-START BOTH PUMPS AT 1310
		NOTE: OPERATING AT 5.2' TO FACILITATE IN HEAVY SNOW PLOWING AND MINIMIZE STREET FLOODING PROBLEMS											
1400	1.43	L.R.	CLDY	SW	6-8	29.10 ↓	7.3 (PEAK)	5.2					3.3'-BOTH PUMPS RUNNING
1500	1.43	-	CLDY	SW	6-8	29.08	6.8	5.2					2.9'-START OPENING AT 5.4'
1600	1.43	-	CLDY	SW	10-12	29.10 ↑	5.4	5.2					2.2'-STARTED OPENING
1620	1.43						4.7	4.7					COMPLETED OPENING
													ISSUE BULLETIN #1

NED FORM SEP 66 563

PLATE A-12

STAMFORD, CONN. T.M. 75 W. DATUM = NGVD
TIDE PREDICTIONS (HIGH AND LOW WATERS) YEAR 1982 MONTH 2
DATUM .540
NOAA, NATIONAL OCEAN SURVEY (EASTERN STANDARD TIME)

DAY	TIME	HT.	TIME	HT.	TIME	HT.	TIME	HT.
1	411	4.3	1042	-3.4	1642	3.3	2256	-3.4
2	514	4.3	1150	-3.5	1748	3.2		
3	2	-3.3	619	4.4	1301	-3.7	1859	3.3
4	112	-3.4	725	4.6	1408	-4.0	2006	3.5
5	218	-3.7	831	4.9	1507	-4.4	2108	3.9
6	319	-4.0	930	5.1	1602	-4.7	2205	4.2
7	416	-4.2	1023	5.3	1652	-4.9	2257	4.5
8	508	-4.4	1113	5.3	1741	-4.9	2345	4.7
9	557	-4.4	1201	5.1	1826	-4.8		
10	29	4.7	645	-4.3	1247	4.8	1910	-4.5
11	114	4.6	732	-4.1	1332	4.4	1952	-4.1
12	159	4.3	820	-3.7	1415	3.9	2036	-3.7
13	241	4.1	906	-3.3	1500	3.4	2120	-3.2
14	326	3.7	957	-3.0	1550	3.0	2209	-2.8
15	416	3.4	1054	-2.7	1643	2.6	2304	-2.5
16	510	3.2	1156	-2.6	1745	2.4		
17	5	-2.3	611	3.1	1256	-2.6	1851	2.3
18	104	-2.2	710	3.2	1354	-2.7	1950	2.5
19	200	-2.4	805	3.4	1445	-3.0	2042	2.7
20	251	-2.6	855	3.6	1530	-3.3	2127	3.0
21	335	-2.8	936	3.9	1609	-3.5	2208	3.4
22	417	-3.1	1017	4.2	1646	-3.7	2245	3.7
23	454	-3.4	1054	4.4	1721	-3.9	2319	4.1
24	532	-3.7	1132	4.5	1754	-4.0	2355	4.4
25	610	-3.9	1212	4.6	1831	-4.1		
26	35	4.6	652	-4.0	1254	4.5	1909	-4.1
27	116	4.8	735	-4.0	1337	4.4	1951	-4.0
28	203	4.8	825	-3.9	1427	4.1	2038	-3.8

TIDE PREDICTIONS
DAILY HIGH AND LOW TIDES

STAMFORD, CONN. T.M. 75 W. DATUM = NGVD (EASTERN STANDARD TIME)
PREDICTED HOURLY HEIGHTS YEAR 1982 MONTH 2 DATUM .540 *NOAA, NATIONAL OCEAN SURVEY* .0000000

DAY	HOURS (cm) 0/12	HOURS 1/13	HOURS 2/14	HOURS 3/15	HOURS 4/16	HOURS 5/17	HOURS 6/18	HOURS 7/19	HOURS 8/20	HOURS 9/21	HOURS 10/22	HOURS 11/23
1	-1.9	-.1	1.9	3.5	4.3	4.0	3.0	1.4	-.5	-2.2	-3.2	-3.4
1	-2.8	-1.5	.2	2.0	3.1	3.3	2.7	1.5	-.2	-1.9	-3.0	-3.4
2	-2.9	-1.8	-.0	2.0	3.6	4.3	4.1	3.1	1.5	-.4	-2.1	-3.2
2	-3.5	-3.0	-1.8	.0	1.8	2.9	3.2	2.7	1.6	-.0	-1.7	-2.9
3	-3.3	-3.0	-1.9	-.1	2.0	3.6	4.4	4.2	3.3	1.7	-.3	-2.1
3	-3.3	-3.7	-3.3	-2.1	-.2	1.7	2.9	3.3	2.9	1.8	.2	-1.6
4	-2.9	-3.4	-3.2	-2.1	-.2	1.9	3.7	4.5	4.5	3.6	1.9	-.2
4	-2.1	-3.5	-4.0	-3.6	-2.3	-.3	1.6	3.0	3.5	3.2	2.1	.3
5	-1.5	-3.0	-3.6	-3.4	-2.3	-.3	2.0	3.8	4.8	4.8	3.8	2.0
5	-.2	-2.3	-3.8	-4.4	-4.0	-2.5	-.3	1.8	3.3	3.9	3.6	2.3
6	.4	-1.6	-3.2	-3.9	-3.7	-2.5	-.3	2.1	4.0	5.0	5.0	3.9
6	2.0	-.4	-2.6	-4.1	-4.7	-4.1	-2.5	-.1	2.1	3.7	4.2	3.8
7	2.4	.3	-1.8	-3.4	-4.2	-3.9	-2.5	-.2	2.3	4.2	5.2	5.1
7	3.9	1.7	-.8	-3.0	-4.4	-4.9	-4.1	-2.2	.3	2.6	4.1	4.5
8	3.9	2.3	.1	-2.1	-3.7	-4.4	-4.0	-2.3	.1	2.6	4.4	5.2
8	4.9	3.5	1.2	-1.3	-3.4	-4.6	-4.8	-3.8	-1.7	.9	3.1	4.4
9	4.6	3.8	2.0	-.3	-2.5	-3.9	-4.4	-3.8	-2.0	.5	2.9	4.5
9	5.1	4.6	3.0	.7	-1.8	-3.7	-4.7	-4.6	-3.3	-1.0	1.5	3.5
10	4.6	4.6	3.5	1.6	-.8	-2.8	-4.0	-4.3	-3.4	-1.5	1.0	3.2
10	4.5	4.8	4.0	2.3	.0	-2.2	-3.8	-4.5	-4.1	-2.6	-.3	2.1
11	3.8	4.5	4.3	3.0	1.0	-1.2	-3.0	-3.9	-3.9	-2.9	-1.0	1.4
11	3.0	4.3	4.3	3.4	1.6	-.6	-2.5	-3.8	-4.1	-3.5	-1.9	.4
12	2.5	3.9	4.3	3.8	2.5	.5	-1.5	-3.0	-3.7	-3.5	-2.4	-.4
12	1.7	3.2	3.9	3.7	2.7	.9	-1.0	-2.7	-3.5	-3.6	-2.8	-1.1
13	1.0	2.8	3.9	4.0	3.4	2.0	.1	-1.7	-2.9	-3.3	-3.0	-1.8
13	-.0	1.8	3.0	3.4	3.1	2.0	.4	-1.3	-2.6	-3.2	-3.1	-2.2
14	-.5	1.4	2.9	3.7	3.6	2.9	1.5	-.2	-1.7	-2.7	-3.0	-2.6
14	-1.4	.2	1.8	2.7	3.0	2.6	1.5	.1	-1.4	-2.4	-2.8	-2.6
15	-1.7	-.1	1.6	2.9	3.4	3.3	2.5	1.2	-.3	-1.7	-2.5	-2.7
15	-2.3	-1.2	.3	1.7	2.4	2.6	2.2	1.2	-.1	-1.3	-2.2	-2.5
16	-2.8	-1.3	.2	1.7	2.8	3.2	3.1	2.3	1.1	-.4	-1.6	-2.3
16	-2.5	-2.2	-1.1	.3	1.5	2.2	2.4	2.0	1.1	-.1	-1.2	-2.0
17	-2.3	-2.0	-1.1	.3	1.8	2.8	3.1	3.0	2.2	1.0	-.4	-1.6
17	-2.3	-2.6	-2.2	-1.1	.2	1.5	2.2	2.3	2.0	1.1	-.1	-1.2
18	-1.9	-2.2	-2.0	-1.0	.4	1.9	2.8	3.2	3.0	2.2	.9	-.5
18	-1.7	-2.5	-2.7	-2.3	-1.1	.4	1.6	2.3	2.4	2.1	1.1	-.1
19	-1.3	-2.1	-2.4	-2.0	-1.0	.6	2.1	3.0	3.4	3.1	2.2	.8
19	-.8	-2.0	-2.8	-3.0	-2.3	-1.0	.6	1.9	2.6	2.7	2.2	1.1
20	-.3	-1.6	-2.3	-2.6	-2.1	-.8	.9	2.4	3.4	3.6	3.2	2.1
20	.4	-1.2	-2.5	-3.2	-3.1	-2.3	-.7	1.0	2.3	2.9	2.9	2.2
21	.8	-.7	-2.0	-2.7	-2.8	-2.1	-.5	1.4	2.9	3.8	3.9	3.2
21	1.0	-.1	-1.8	-3.0	-3.5	-3.2	-2.0	-.2	1.7	2.9	3.4	3.1
22	2.0	.4	-1.3	-2.5	-3.1	-2.9	-1.9	-.0	2.0	3.5	4.1	4.0
22	3.0	1.3	-.8	-2.5	-3.5	-3.7	-3.0	-1.5	.6	2.4	3.5	3.7
23	3.1	1.7	-.2	-2.0	-3.1	-3.4	-2.9	-1.5	.6	2.6	4.0	4.4
23	3.9	2.5	.6	-1.5	-3.1	-3.9	-3.7	-2.6	-.7	1.5	3.2	4.0
24	3.9	2.8	1.1	-.9	-2.6	-3.6	-3.6	-2.7	-1.0	1.3	3.3	4.4
24	4.4	3.6	1.9	-.3	-2.3	-3.6	-4.0	-3.5	-2.0	.1	2.4	3.9
25	4.4	3.8	2.5	.5	-1.7	-3.2	-3.9	-3.6	-2.4	-.4	1.9	3.8
25	4.6	4.3	3.1	1.2	-1.1	-3.0	-4.0	-4.0	-3.1	-1.3	1.1	3.2
26	4.4	4.5	3.6	2.0	-.2	-2.3	-3.7	-4.0	-3.4	-1.9	.2	2.5
26	4.1	4.5	3.9	2.5	.4	-1.8	-3.4	-4.1	-3.7	-2.5	-.5	1.9
27	3.8	4.7	4.5	3.3	1.5	-.8	-2.7	-3.9	-4.0	-3.1	-1.5	.7
27	2.8	4.1	4.3	3.5	1.9	-.2	-2.2	-3.6	-4.0	-3.4	-1.9	.2
28	2.5	4.2	4.8	4.3	3.0	1.0	-1.1	-2.9	-3.8	-3.8	-2.8	-1.1
28	1.0	2.9	4.0	3.9	3.0	1.4	-.6	-2.4	-3.6	-3.7	-3.0	-1.5

PREDICTED HOURLY

TIDE HEIGHTS

PLATE A-14

A P P E N D I X B

CITY OF STAMFORD
STANDARD OPERATING PROCEDURES

APPENDIX B

TABLE OF CONTENTS

APPENDIX B

LIST OF PLATES

Plate	Title
B-1	General Plan - Stamford Harbor
B-2	Tracks of Major Hurricanes and Areas of Operational Phases
B-3	Standard Operating Procedure for Hurricanes
B-4	Standard Operating Procedure for Coastal Storms
B-5	Cummings Pumping Station - Operation Log
B-6	Dyke Lane Pumping Station - Operation Log
B-7	Wampanaw Pumping Station - Operation Log

APPENDIX B

STAMFORD HURRICANE BARRIER
STANDARD OPERATING PROCEDURE (SOP)
FOR HURRICANES AND COASTAL STORMS

B-01. General. This appendix contains the regulation procedures for portions of the hurricane protection project which are operated and maintained by the city of Stamford. Plates B-3 and B-4 contain Stamford operating procedures (SOP).

The previous standard operating procedure for the Dyke Lane pumping station included instructions to the Hartford Electric Company power plant to close their 8-foot diameter outlet gate and divert all cooling water and surface runoff to Dyke Lane pumping station during excessive high tides. Since the power plant discontinued operations in 1974 the 8-foot gate has been closed and the 78-inch diversion gate open. Only surface drainage is now diverted to the pumping station.

Operational considerations during regulation periods are divided into "Phases" to assure clear delineation of responsibilities and actions to be taken by Stamford as a hurricane or coastal storm approaches New England. Arrangements should be made to receive advisories from the National Weather Service (NWS).

B-02. Regulation During Hurricanes. Refer to plate B-2 for "Alert", "Watch" and "Warning" phases.

a. Phase 1 - Alert. Hurricane is located north of 27^{o} latitude and west of 67^{o} longitude, and NWS announces that a hurricane poses a possible threat to southern New England. The city of Stamford will alert all personnel connected with operation of the project, and maintain a plot of the hurricane position during all five phases.

b. Phase 2 - Watch. Hurricane "Watch" announced by NWS for southern New England coast or hurricane center crosses 35^{o} latitude and is possibly headed for southern New England.

(1) Test pumps and sluice gates at Dyke Lane, Wampanaw and Cummings pumping stations.

(2) Test all equipment necessary for operation. Check materials and supplies such as report forms, etc.

(3) Maintain plot of predicted and observed tides.

c. Phase 3 - Warning. Hurricane "Warning" announced by NWS

for southern New England coast or hurricane center crosses 38° latitude and is still moving towards southern New England.

(1) Mobilize full complement of personnel.

(2) Open sump gates at Wampanaw and Cummings stations.

(3) Open gates into large sump at Dyke Lane station.

(4) Keep log of operations - suggested forms are shown on plates B-5 through B-7.

d. Phase 4 - Tidal Surge. Rising hurricane tide is commencing and tide is approaching plus 3 feet. All elevations are in feet above National Geodetic Vertical Datum (NGVD). Operate as follows:

(1) Start one pump and close bypass gate at both Wampanaw and Cummings stations.

(2) Operate pumps at all stations as required per schedules (see plate B-3).

(3) Close the 18-inch gate and two valves (12" and 6") located on sanitary sewers that pass through the Westcott Cove barrier.

(4) Maintain complete log of operations.

e. Phase 5 - Cessation. The cessation phase should not be initiated until it is certain that the storm no longer threatens the area. Consequently, if the tide recedes below elevation 4 feet following a tidal surge operation and there is some question concerning the location and movement of the storm, the city should not initiate the cessation phase, but should revert to the warning phase and be prepared to resume operations if necessary. However, if the tide recedes below elevation 4 feet and high tides are no longer a threat to the area, the city will:

(1) Open sanitary sewer gate and two valves in Westcott Cove barrier.

(2) Open bypass gates and close sump gates at Wampanaw and Cummings stations.

(3) Stop pumps at Wampanaw and Cummings stations as per schedule.

(4) When inflow to Dyke Lane station permits, close gates into large sump and revert to normal operation.

(5) Complete logs of all phases of operation and prepare reports.

(6) Demobilize except for personnel required for maintenance and cleaning, such as evacuating remaining water in sumps with sump pumps, flushing walls and floors, etc.

B-03. Regulation During Coastal Storms

a. Phase 1 - Alert. The NWS announces that a storm south of New England poses a possible threat of tidal flooding to the Stamford area. The city will:

(1) Alert all personnel connected with the operation of the project.

(2) Keep informed on NWS reports on the location and possible intensification of the storm.

(3) Check time and height of predicted high tides.

b. Phase 2 - Watch. Based on NWS weather and tidal forecasts it is expected that tides will exceed 6.0 feet within the next 8-hour period. The city will initiate staffing of Dyke Lane, Wampanaw and Cummings stations when tide conditions indicate need.

c. Phase 3 - Operation. Tide rising and expected to reach 6.0 feet within 1 hour with interior runoff.

(1) Tide 6.0 feet and rising

Open sump gate, start pump and close bypass gate at Cummings station.

(2) Tide 6.2 feet and rising

(a) Open sump gate, start pump and close bypass gate at Wampanaw station.

(b) Open gates into large sump at Dyke Lane station.

(c) Operate large pumps at Dyke Lane station per schedule.

(3) Operate pumps at all stations per schedules.

(4) Maintain complete log of operations including sump and tide elevations.

d. Phase 4 - Cessation. Tide recedes to 6.0 feet msl and is no longer a threat to the area.

(1) Close sump gates and open bypass gates at Wampanaw and Cummings stations.

(2) Rate of inflow permitting, close large sump gates and drain large sump at Dyke Lane station.

(3) Stop pumps at Wampanaw, Cummings and Dyke Lane stations as per schedules.

(4) Complete logs of all phases of operations and prepare reports.

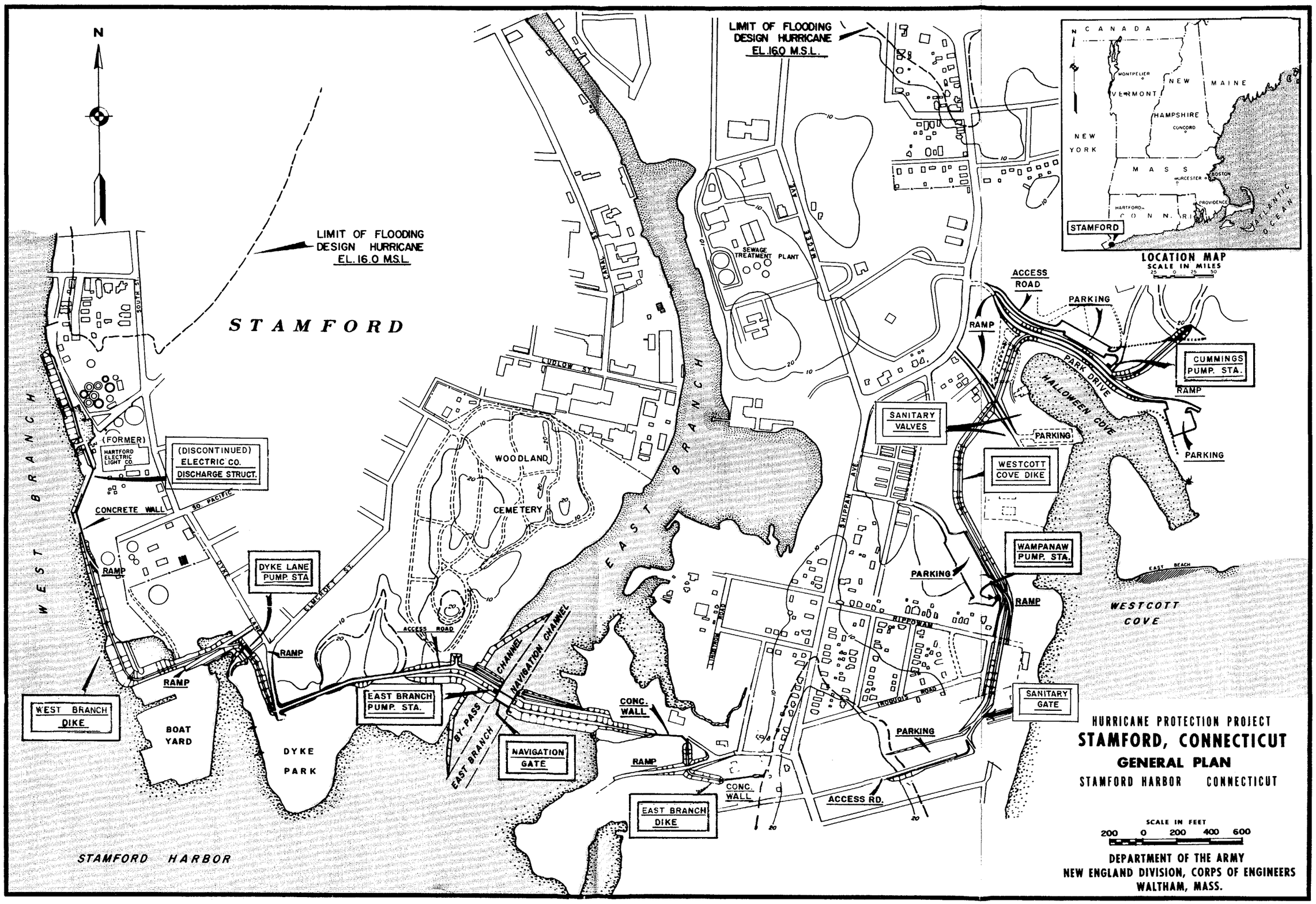
(5) Demobilize, except for personnel required for cleaning, such as evacuating remaining water in sumps with sump pumps, flushing walls and floors, etc.

B-04. Operation During Normal Tide Conditions. The two small pumps at the Dyke Lane pumping station are under automatic operation for discharging normal drainage. When inflow to the station exceeds the capacity of the small pumps and the water level in the sump rises to minus 4.5 feet NGVD, an alarm will be sounded in the city incinerator office. The city will then dispatch personnel to the Dyke Lane station to place the larger pumps in operation. These pumps will be operated according to the schedule on plate B-3 until conditions permit return to normal operation.

B-05. Reports. Prior to and during operation of the project for hurricanes or coastal storms, information pertinent to any operation will be entered on a log or forms as shown on plates B-5 through B-7. The report will include times of gate openings and closings, pumping operations, sump and ocean elevations, operational phases, and any other information or observations that would help in describing the entire operation. If requested, a copy of the report will be furnished to the New England Division, Attention: Reservoir Control Center.

CORPS OF ENGINEERS

U.S. ARMY



HURRICANE PROTECTION PROJECT

STAMFORD, CONNECTICUT

GENERAL PLAN

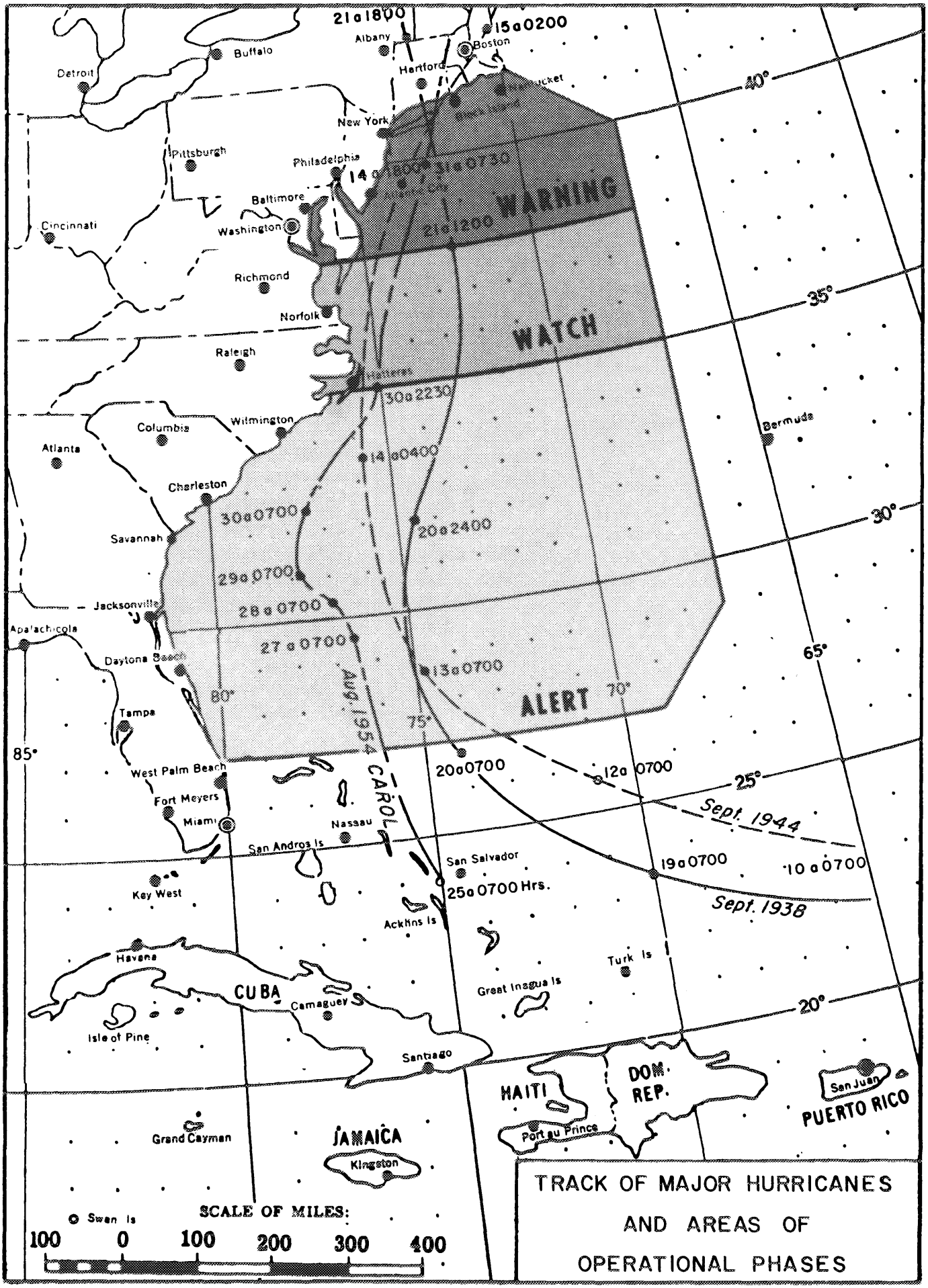
STAMFORD HARBOR CONNECTICUT

SCALE IN FEET

200 0 200 400 600

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE NO. B-1



TRACK OF MAJOR HURRICANES AND AREAS OF OPERATIONAL PHASES

PLATE B-2

STANDARD OPERATING PROCEDURE

FOR HURRICANES

DYKE LANE, WAMPANAW & CUMMINGS PUMPING STATIONS

STAMFORD, CONNECTICUT

PHASE I ALERT

CONDITIONS	PROCEDURAL DUTIES
1. National Weather Service (N.W.S.) Announces That A Hurricane Off The Atlantic Coast Poses A Possible Threat To Southern New England And / Or Hurricane Crosses 27° Latitude.	1. City Official In Charge Will Alert All Personnel Necessary To Operate Pumping Stations. 2. City Official In Charge Will Keep Informed Of Developing Conditions, And Maintain Plot Of Hurricane Position.

PHASE II WATCH

CONDITIONS	PROCEDURAL DUTIES
1. Hurricane "Watch" Announced By N.W.S. For Southern New England Coast And/Or Hurricane Crosses 35° Latitude, And Is Possibly Headed For Southern New England.	1. City Will Test Pumps And Sluice Gates At All Stations. 2. Maintain Plot Of Predicted And Observed Tides. 3. Test All Equipment Necessary For Operation - Check For Materials And Supplies.

PHASE III WARNING

CONDITIONS	PROCEDURAL DUTIES
1. Hurricane Warning Announced By N.W.S. For Southern New England Coast And/Or Hurricane Crosses 38° Latitude.	1. Full Complement Of Personnel Mobilized. 2. Open Sump Gates At Wampanaw And Cummings Pumping Stations. 3. Open Large Sump Gates At Dyke Lane Pumping Station. 4. Keep Log Of Gate Operations Plus Tide And Sump Elevations.

PHASE IV SURGE

CONDITIONS	OPERATION
1. Rising Hurricane Tide Is Commencing And Approaching +3.0'.*	1. Start One Pump And Close Bypass Gate At Both Cummings And Wampanaw Stations. 2. Operate Pumps At All Stations As Required Per Schedules. 3. Close Sanitary Sewer Gates And Two Valves In Westcott Cove Barrier. 4. Maintain Complete Log Of Operations.

PHASE V CESSATION

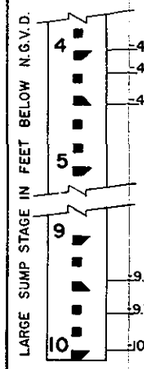
CONDITIONS	OPERATION
1. Tide Receding Below Elevation +4.0'* And High Tides Are No Longer A Threat To Area.	1. Open Sanitary Sewer Gates And Valves In Westcott Cove Barrier. 2. Open Bypass Gate And Close Sump Gates At Wampanaw And Cummings Stations. 3. When Inflow to Dyke Lane Pumping Station Permits, Close Gates To Large Sump. 4. Complete Logs and Return All Stations To Pre-hurricane Conditions.

NOTE:

The City Of Stamford Is Responsible For Operating The Large Pumps At Dyke Lane Station During Periods Of High Interior Runoff Regardless Of Tide Elevation. A Warning Device Will Be Activated When The Sump Level Indicates Need For Operation And The Pumps Will Be Operated Per Schedule Until Conditions Permit Return To Automatic Operation.

*All Elevations In Feet Above National Geodetic Vertical Datum (N.G.V.D.).

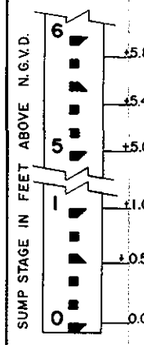
DYKE LANE PUMPING SCHEDULE FOR LARGE PUMPS



4.0' And Rising - Start 3rd. Large Pump
4.2' And Rising - Start 2nd. Large Pump
4.5' And Rising - Start 1st. Large Pump

9.4' And Falling - Stop 3rd. Large Pump
9.7' And Falling - Stop 2nd. Large Pump
10.0' And Falling - Stop 1st. Large Pump

WAMPANAW AND CUMMINGS PUMPING SCHEDULES



+5.8' And Rising - Start 3rd. Pump *(Cummings Station Only)*
+5.4' And Rising - Start 2nd. Pump
+5.0' And Rising - Start 1st. Pump

+1.0' And Falling - Stop 3rd. Pump. *(Cummings Station Only)*
+0.5' And Falling - Stop 2nd Pump.
0.0' And Falling - Stop 1st. Pump.

NOTE:
If Rise In Sump Recurs After Stopping, Start A Pump Not Previously Used. The Same Pump Should Not Be Started More Than Twice In A One-Hour Period Except When Necessary To Prevent Serious Flooding.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS

DR BY | TR BY MWB | CK BY

STAMFORD HURRICANE PROJECT
STANDARD OPERATING PROCEDURE FOR HURRICANES
DYKE LANE, WAMPANAW & CUMMINGS PUMPING STATION
STAMFORD CONNECTICUT

PROJECT ENGINEER
CHIEF SECTION
SUBMITTED BY
CHIEF
APPROVED
CHIEF ENGINEERING DIVISION
DRA

PLATE B-3

STANDARD OPERATING PROCEDURE

FOR COASTAL STORMS

DYKE LANE, WAMPANAW & CUMMINGS PUMPING STATIONS

STAMFORD, CONNECTICUT

PHASE I ALERT

CONDITIONS WARRANTING	PROCEDURAL DUTIES
1. The National Weather Service (N.W.S.) Announces That A Storm South Of New England Poses A Possible Threat Of Tidal Flooding To The Stamford Area.	1. City Official In Charge Will Alert All Personnel Necessary For Staffing. 2. Keep Informed Of N.W.S. Reports On The Location And Intensification Of Storm. 3. Check Time And Height Of Predicted High Tides.

PHASE II WATCH

CONDITIONS WARRANTING	PROCEDURAL DUTIES
1. Based On N.W.S. Weather And Tidal Forecasts And Observed Surge At Stamford. It Is Expected That Tides Will Exceed + 6.0'* Within Next 8 Hour Period.	1. City Official In Charge Will Initiate Staffing Of Pumping Stations When Tide Conditions Indicate Need.

PHASE III OPERATION

CONDITIONS WARRANTING	OPERATIONS
1. Tide Rising And Expected To Reach 6.0 Feet Within One Hour.	1. Tide +6.0' And Rising (a) Open Sump Gate, Start A Pump And Close By-Pass Gate At Cummings Pumping Station. 2. Tide +6.2' And Rising (a) Open Sump Gate, Start A Pump And Close By-Pass Gate At Wampanaw Pumping Station. 3. Tide +6.2' And Rising (a) Open Large Sump Gates At Dyke Pumping Station. (b) Operate Large Pumps At Dyke Lane Pumping Station Per Schedule. (See Plate B-3) 4. Operate Pumps At All Stations Per Schedules. 5. Maintain Complete Log Of Operations Plus Sump And Tide Elevations.

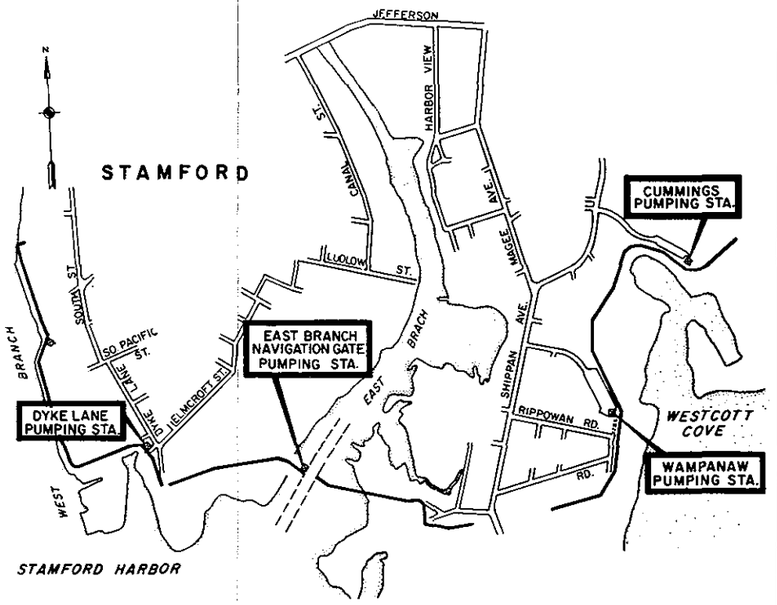
PHASE IV CESSATION

CONDITIONS WARRANTING	OPERATIONS
1. Tide Recedes To + 6.0' And Falling. 2. Tides No Longer Threat To Area.	1. Close Sump Gates And Open By-Pass Gate At Wampanaw And Cummings Pumping Stations. 2. Rate Of Inflow Permitting, Close Large Sump Gates And Drain Large Sump At Dyke Lane Pumping Station. 3. Stop Pumps At Wampanaw, Cummings And Dyke Lane Stations As Per Schedule. 4. Complete Log Of Operations.

NOTE:

The City Of Stamford Is Responsible For Operating The Large Pumps At Dyke Lane Station During Periods Of High Interior Runoff Regardless Of Tide Elevation. A Warning Device Will Be Activated When The Sump Level Indicates Need For Operation And The Pumps Will Be Operated Per Schedule Until Conditions Permit Return To Automatic Operation.

* All Elevations In Feet Above National Geodetic Vertical Datum (N.G.V.D.).



STAMFORD HARBOR

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF

STAMFORD HURRICANE PROJECT

STANDARD OPERATING PROCEDURE FOR COASTAL STORMS

DYKE LANE, WAMPANAW & CUMMINGS PUMPING STATION

STAMFORD CONNECTICUT

APPROVED DATE

CHIEF ENGINEERING DIVISION

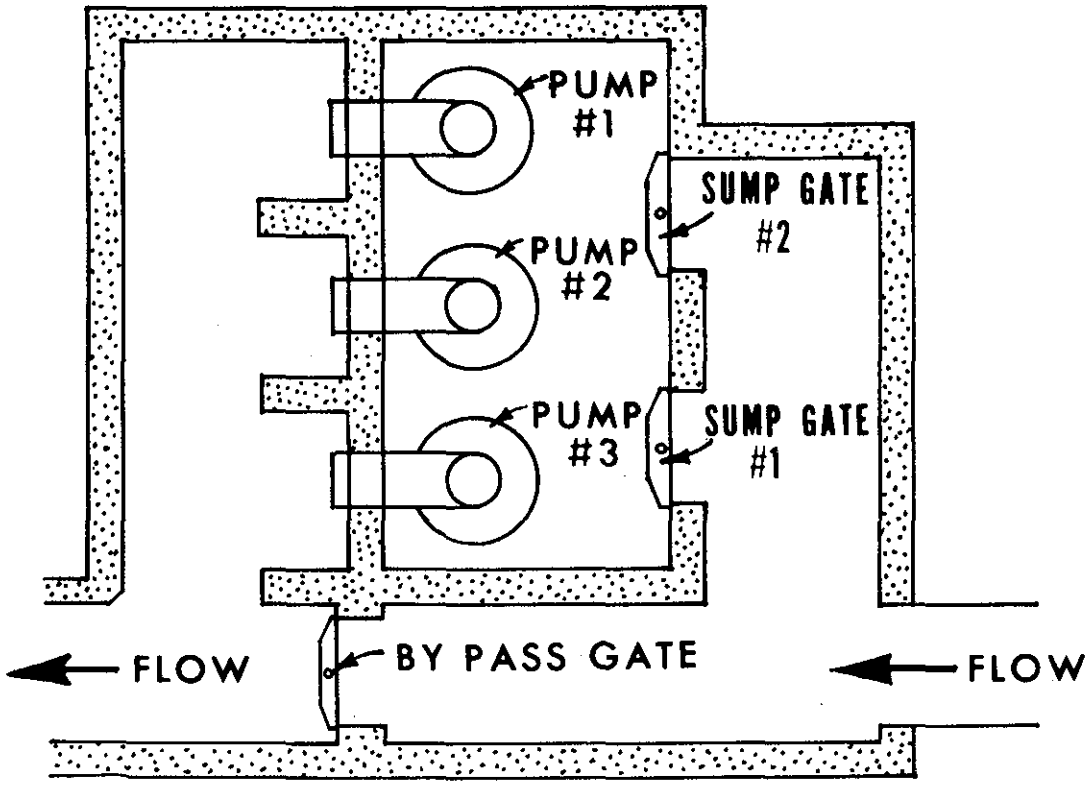
SCALE

DRAWING NUMBER

SHEET

PLATE B-4

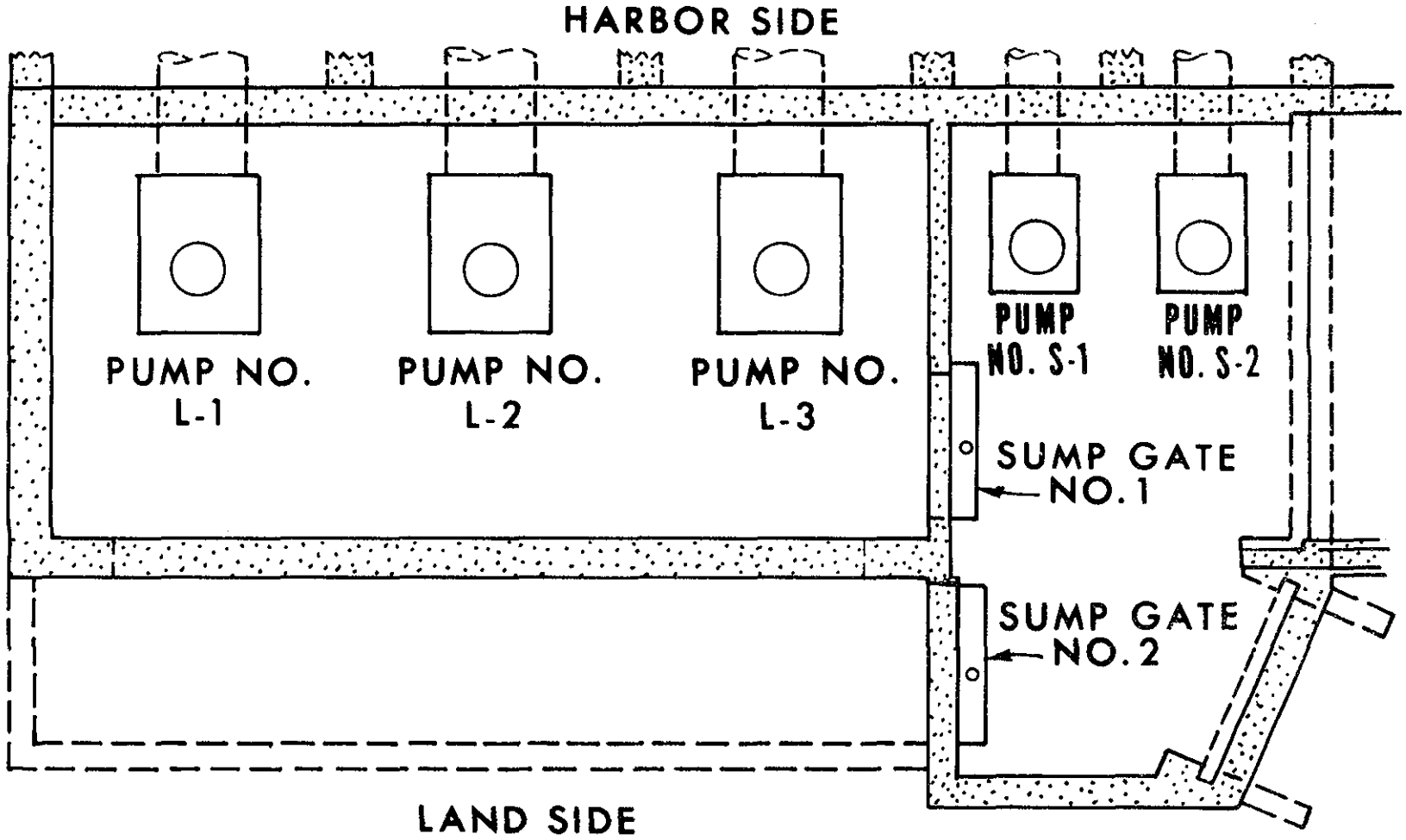
CUMMINGS
PUMPING STATION - OPERATION LOG



TIME	OCEAN EL.	SUMP EL.	BY PASS GATE	SUMP GATES		PUMPS			REMARKS
				NO.1	NO. 2	NO.1	NO. 2	NO. 3	

PLATE B-5

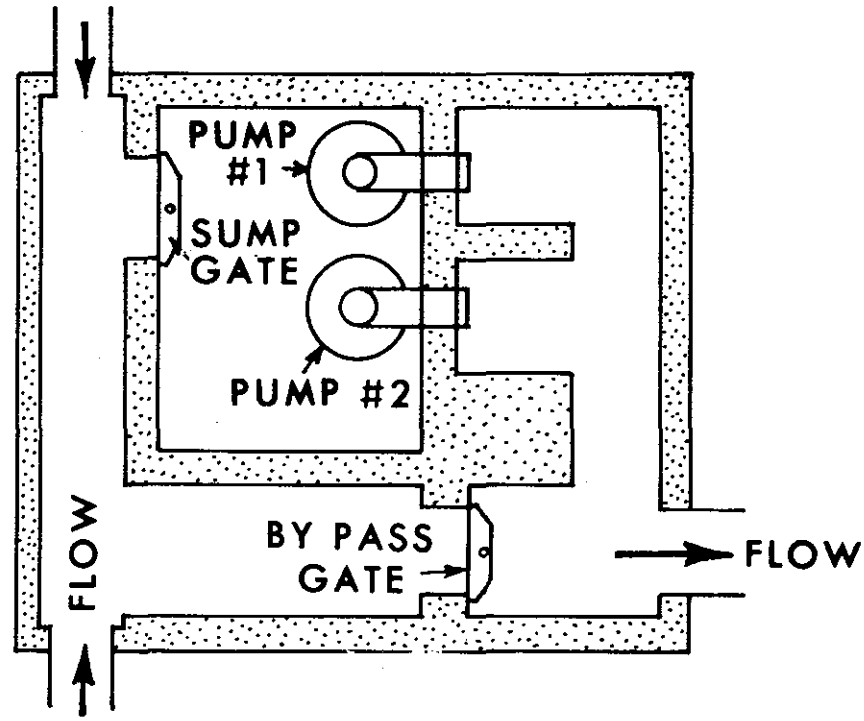
DYKE LANE PUMPING STATION OPERATION LOG



TIME	TIDE EL.	SUMP EL.	GATES		PUMPS					REMARKS
			NO. 1	NO.2	NO.L-1	L-2	L-3	S-1	S-2	

PLATE NO. B-6

WAMPANAW
PUMPING STATION - OPERATION LOG



TIME	OCEAN EL.	SUMP EL.	BY PASS GATE	SUMP GATE	PUMP #1	PUMP #2	REMARKS

PLATE NO. B-7